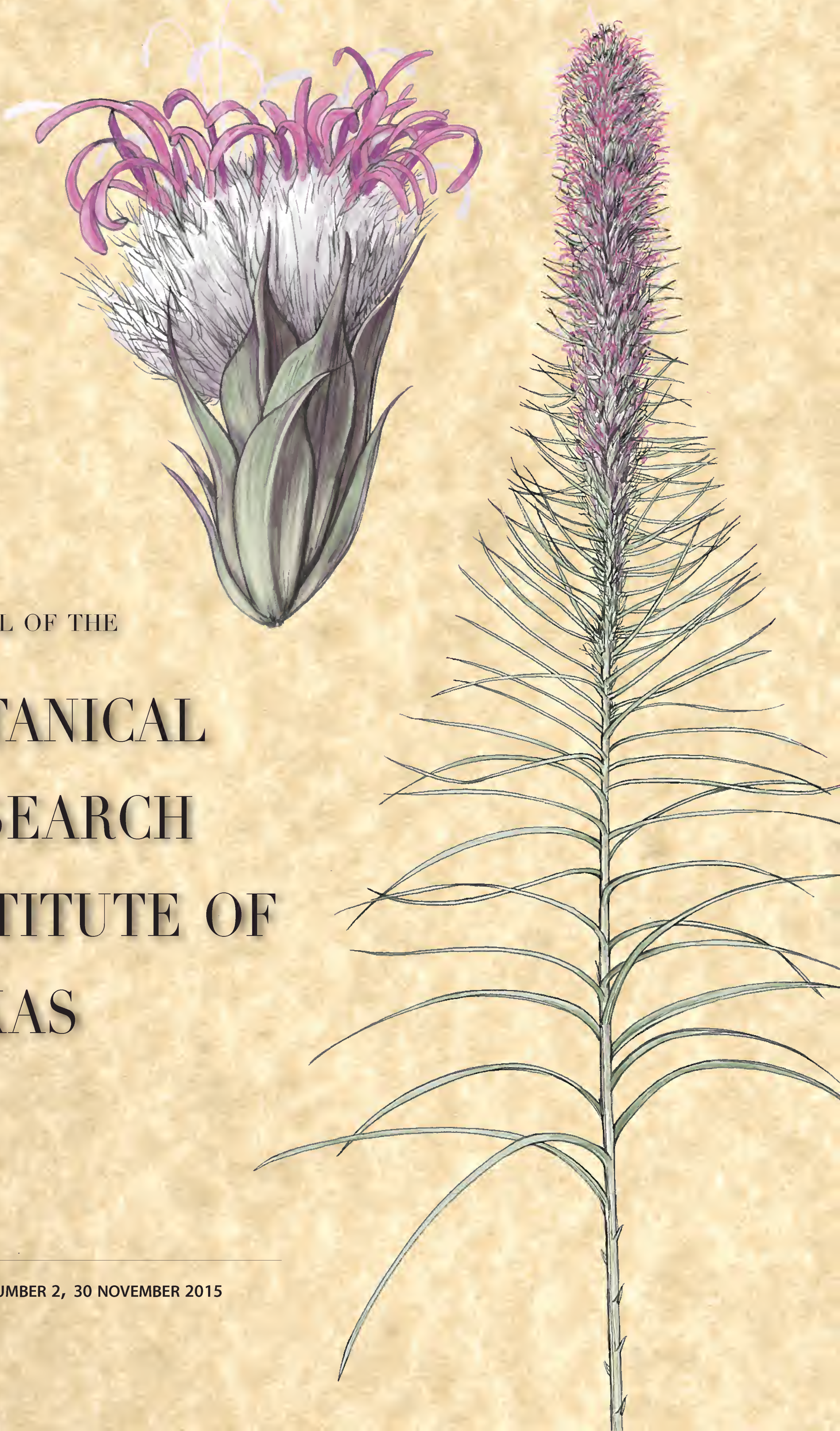

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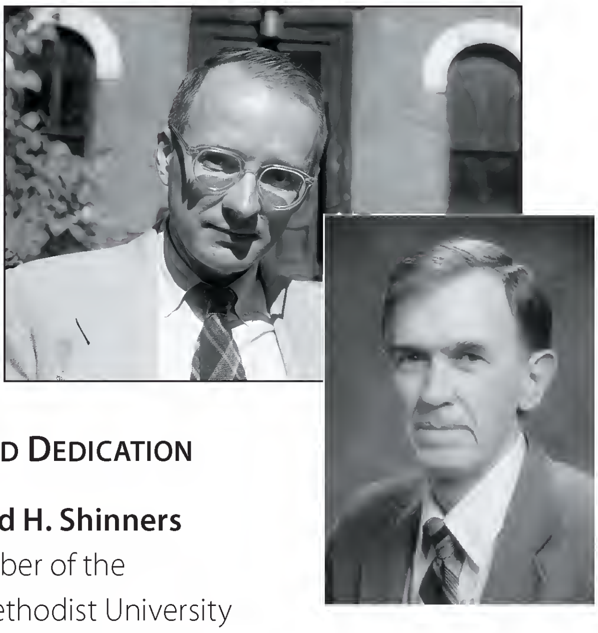

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**1971—William F. Mahler** (right), professor of botany at SMU and director emeritus of BRIT, inherited editorship and copyright.

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Botanical Research Institute of Texas (BRIT)
1700 University Dr.
Fort Worth, Texas 76107-3400, USA
817-332-7432; 817-332-4112 fax
Email: barney@brit.org; jbrit@brit.org

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Electronically tinted botanical illustration of *Liatris aestivalis* originally used on BRIT's anniversary poster 2001. Summer gayfeather flowers mid Jul–Aug(–Sep) and is endemic to Oklahoma and Texas. Sida 19:768. 2001. Botanical illustration by Linny Heagy ©2001.

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# *BOTRYCHIUM MICHIGANENSE* SP. NOV. (OPHIOGLOSSACEAE), A NEW NORTH AMERICAN MOONWORT

Arthur V. Gilman

*Gilman & Briggs Environmental*
*1 Conti Circle, Suite 5*
*Barre, Vermont 05641, U.S.A.*
*avgilman@together.net*

Donald R. Farrar

*Department of Ecology, Evolution and Organismal Biology*
*Iowa State University*
*Ames, Iowa 50011, U.S.A.*

Peter F. Zika

*WTU Herbarium*
*Box 355325, University of Washington*
*Seattle, Washington 98195, U.S.A.*

## ABSTRACT

**Botrychium michiganense** W.H. Wagner ex A.V. Gilman, Farrar & Zika is described as a new moonwort species. It is an allotetraploid, most likely descended from hybrids between ancestral *B. lanceolatum* s.l. and *B. pallidum*. It has a pinnate to pinnate-pinnatifid trophophore (sterile segment) and is most similar to *B. hesperium* and *B. matricariifolium*. These three species can be distinguished by trophophore shape and dissection and *B. michiganense* is genetically distinct from the others as evidenced by different allozyme profiles. *Botrychium michiganense* ranges from New Brunswick, the St. Lawrence region of Quebec, the Great Lakes region of the US and Canada, the Black Hills of South Dakota, and west through the Rocky Mountains to eastern British Columbia and Washington.

## RESUMÉ

**Botrychium michiganense** W.H. Wagner ex A.V. Gilman, Farrar & Zika est décrit comme une nouvelle espèce de botryche. Il s'agit d'un allotétraploïde issu de croisements entre une lignée ancestrale probable du *B. lanceolatum* s.l. et le *B. pallidum*. Il possède un trophophore (segment stérile) penné à penné-pennatifide et ressemble beaucoup au *B. hesperium* et au *B. matricariifolium*. On peut le reconnaître par la forme et la découpure de son trophophore ainsi que par des caractères génétiques distincts mis en évidence par des profils alloenzymatiques différents. Il se retrouve au Nouveau-Brunswick et dans la vallée du Saint-Laurent au Québec, dans la région états-unienne et canadienne des Grands Lacs, dans les Black Hills au Dakota du Sud, puis à l'ouest, dans les Montagnes Rocheuses jusque dans l'est de la Colombie-Britannique et dans l'État de Washington.

## INTRODUCTION

The moonworts (*Botrychium* Sw. subgenus *Botrychium*) of North America include about 30 species, most of which were described in the past 35 years (Wagner & Wagner 1981, 1983b, 1986, 1990a, 1990b, 1993, 1994; Farrar & Johnson-Groh 1991; Stensvold et al. 2002; Wagner & Grant 2002). Several putative new species remain under study (Stensvold 2008; Farrar & Popovich 2012). Many species are morphologically cryptic, separated by subtle differences of trophophore (sterile segment) shape and lobing, pinna shape, and dissection. Treatment of these entities as evolutionary species is well-supported by cytological, isozyme, and DNA data (Wagner 1993; Hauk 1995; Hauk & Haufler 1999; Zika & Farrar 2009).

In this paper we examine plants initially confused with *Botchium matricariifolium* A. Br. in the Great Lakes area and with *B. hesperium* (Maxon & Clausen) Wagner & Lellinger in the Black Hills and Rocky Mountains. Wagner and Wagner (1990a) reported the apparent discovery of *B. hesperium* in Ontario and Michigan, but later they hypothesized these plants represented a new, undescribed species, which they informally called "B. michiganense." This hypothesis received support from the findings of Hauk and Haufler (1999: Table 3) who reported differences between a Great Lakes population (i.e., "B. michiganense" including Wagner's collection *86045*) and a western population (i.e., typical *B. hesperium*) in three allozyme systems (*Pgi-2*, *Dia-1*, and *Mdh-1*) of six that they examined. Hauk and Haufler's (1999) results also demonstrated that Wagner's *86045* was, like *B. hesperium* and *B. matricariifolium*, an allotetraploid with fixed heterozygosity. We

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used additional allozyme profiles to analyze relationships between *B. michiganense*, *B. hesperium* and *B. matricariifolium* and potential progenitors. We also compared morphologies of this new taxon with the species it had been confused with, *B. matricariifolium* in the East and *B. hesperium* in the West.

## MATERIALS AND METHODS

### Allozymes

Diagnostic allozyme banding patterns consistent with morphological markers for *B. michiganense* established by W.H. Wagner and the authors were identified from populations in Michigan (including the type locality), Montana and Washington, where *B. michiganense* co-occurs with *B. matricariifolium* and with *B. hesperium* respectively. Continued study of *B. michiganense* across the range of its occurrence along with other twice-dissected (pinnate-pinnatifid) species allowed critical comparison at 20 independently assorting gene loci. For this comparison, 302 individuals of these three allotetraploids from 37 sites were included (Appendix 1). A small portion of the base of the common stalk from each specimen was removed for analysis, and the remainder of the plant was pressed as a voucher and deposited at ISC; such samples of *B. michiganense* are cited in *Additional Specimens* under Farrar numbers, where each number represents a single specimen, not a sheet with multiple specimens.

Ten isozyme systems showing 20 loci were analyzed: aspartate amino transferase (*Aat*), 1-aminocyclopropane-1-carboxylate oxygenase (*Aco*), diaphorase (*Dia*), isocitrate dehydrogenase (*Idh*), malate dehydrogenase (*Mdh*), 6-phosphogluconate dehydrogenase (*6Pgd*), phosphoglucoisomerase (*Pgi*), phosphoglucomutase (*Pgm*), shikimate dehydrogenase (*Skdh*) and triosephosphate isomerase (*Tpi*). Procedures and protocols followed those described by Zika & Farrar (2009).

To determine potential progenitors, results were compared to similar data from three diploid species: *Botrychium lanceolatum* (S.G. Gmel.) Ångstr., *B. angustisegmentum* Pease & A.H. Moore, and *Botrychium pallidum* W.H. Wagner.

### Morphology

We studied more than 225 individuals of *B. michiganense* (Appendix 2), including more than 150 for which allozymes were analyzed, and assessed them for seven morphological variables on the trophophore (Table 1). Specifically, we assessed samples that were growing together in mixed communities, as recommended by Wagner and Wagner (1983a). Such communities are naturally occurring common garden experiments, with all taxa growing under identical conditions. We studied the large populations of *B. matricariifolium* growing with *B. michiganense* at the latter's type locality, Grand Sable Dunes in Michigan's Upper Peninsula, and *B. hesperium* growing with *B. michiganense* at Bestrom Meadow, Stevens County, Washington, at Big Prairie ("Big Meadow") in Glacier National Park, Glacier County, Montana, and at Great Northern Flats of the North Branch, Flathead River, Flathead County, Montana. We also compared plants from these populations with others from communities containing only one taxon, located in regions where *B. michiganense* has not been found: *B. hesperium* from Colorado and *B. matricariifolium* from Vermont. Representative specimens for this assessment are cited in Appendix 2.

## RESULTS

### Allozymes

*Botrychium michiganense* differs from *B. hesperium* at four of 20 loci tested in the ten enzyme systems, and from *B. matricariifolium* at three of 20 loci (Table 2). Allelic patterns indicate that *B. michiganense* is an allotetraploid species (2*n*=180), with fixed heterozygosity displayed at twelve of 20 gene loci. Data indicate that it is related to a common ancestor of *B. angustisegmentum* and *B. lanceolatum*, and to *B. pallidum*.

### Morphology

The genus community tests show that morphological differences observed between multiple taxa growing at remote locations are retained when they grow in proximity. There are consistent differences between

Table 1. Morphological variables assessed on more than 300 individual specimens of *Botrychium michiganense*.

| Character | Variation recorded |
|---|---|
| Trophophore attachment | sessile vs. stalked |
| Trophophore outline | ovate vs. elongate-ovate |
| Relative size of pinnae | basal pinnae much larger than distal pinnae vs. proportionately sized |
| Spacing of medial pinnae | remote vs. overlapping |
| Incisions of non-basal pinnae | both margins vs. only basiscopic margin |
| Pinnae shape | lanceolate-rhombic vs. broadly ovate to obovate |
| Pinnae apex | acute vs. rounded |

Table 2. Alleles expressed at enzyme-coding loci in *B. michiganense* and related species. Allele numbers reflect relative migrating positions within genus *Botrychium*, with alleles of the presumed diploid parents color coded. In allotetraploid combinations, the presumed Sect. *Lanceolatae* contribution is listed first and the presumed Sect. *Lunariae* second using the color of the presumed contributing diploid, or black where the contributor is ambivalent. Allele numbers in () are orphan, not detected in any of the three diploid species, but presumed to have been contributed by the non-*Lanceolatae* parent. Species are *B. angustisegmentum* (ang), *B. lanceolatum* (lan), *B. matricariifolium* (mat), *B. michiganense* (mich), *B. hesperium* (hesp) and *B. pallidum* (pal).

*It is assumed that tetraploid plants have received two homoeologous copies of each gene, but because these genes are redundant in activity, one of the homoeologous copies may have become silenced (n). In these data we have not attempted to detect this possibility at loci receiving the same allele from both parental diploids. Where parental diploids differ in potential contribution but only one allele is expressed, we suggest silencing as the most likely explanation.

**Diploid *Botrychium* species regularly express banding patterns reflecting four independently migrating loci for diaphorase, but *B. pallidum* expresses only 3 bands for this enzyme family. It is possible that Dia-3 has become silenced or that it co-migrates with one of the other loci.

| Locus | ang | lan | mat | mich | hesp | pal |
|---|---|---|---|---|---|---|
| Aat-2 | 3 | 3 | 3+(2) | 3+(2) or 3+3 | 3+3 | 3 |
| Aat-3 | 0.2 | 0.5 | 0.2+2 | 0.2+2 or 0.5+2 | 0.5+2 | 2 |
| Aat-4 | 0.2 | 0.5 | 0.2+3 | 0.2+3 or 0.5+3 | 0.5+3 | 3 |
| Aco-2 | 3 | 3 | 3+3 | 3+3 | 3+3 | 2 or 3 |
| Dia-1 | 1 | 1 | 1+2 | 1+2 | 1+2 | 2 |
| Dia-2 | 1 | 0.5 | 1+1 | 1+1 or 0.5+1 | 0.5+1 | 1 |
| Dia-3 | 2.5 or 3 | 3 | 3+n | 3+n | 3+n* | n** |
| Dia-4 | 5 | 6 | 5+8 | 5+8 | n+8 | 8 |
| Idh-1 | 1 | 1 | 1+1 | 1+1 | 1+1 | 1 |
| Mdh-1 | 2 | 2 | 2+1 | 2+1 | 2+1 | 1 |
| Mdh-2 | 3 | 7 | 3+3 | 7+3 | 7+3 | 3 |
| Mdh-3 | 2.5 or 3 | 2.5 or 3 | 3+2 | 3+2 or 2.5+2 | 3+2 | 2 |
| Mdh-4 | 2 | 2 | 2+2 | 2+2 | 2+2 | 2 |
| 6Pgd | 4 | 4 | 4+1 | 4+1 | 4+1 | 1 |
| Pgi-2 | 4 | 4 | 4+(1) or 4+2 or n+2 | 4+2 | 4+2 or 4+n | 2 |
| Pgm-1 | 3 | 3 | 3+1 or 3+n | 3+1 or 3+n | 3+1 or n+1 | 1 |
| Pgm-2 | 1.5 | 1.5 | 1.5+2 | 1.5+2 | 1.5+2 | 2 |
| Skdh | 2 | 1 | 2+1 or 2+n | 2+1 or 1+1 | 1+1 | 1 |
| Tpi-1 | 3 | 3 | 3+(1) or 3+3 | 3+3 | 3+3 | 3 |
| Tpi-2 | 3 | 3 | 3+3 | 3+3 | 3+3 | 3 |

*Botrychium michiganense*, *B. matricariifolium*, and *B. hesperium* (Table 3) across the known geographic ranges of these species.

## DISCUSSION

### Allozymes

Genetic relationships among twice-dissected allotetraploids of *Botrychium* are complex. Unquestionably, their ancestry includes a twice-dissected (pinnate-pinnatifid) diploid member of *B.* sect. *Lanceolatae* Clausen, and a once-dissected (pinnate) diploid member of *B.* sect. *Lunariae* Clausen (Clausen 1937; Hauk 1995; Hauk &

Table 3. Normal states of morphological characters in *B. michiganense* and species with which it has been confused. All characters are somewhat variable and may not discriminate taxa when used alone.

| Character | *michiganense* | ***Botrychium* sp.**<br>*matricariifolium* | *hesperium* |
|---|---|---|---|
| Trophophore attachment | sessile | stalked | variable |
| Trophophore outline | elongate-ovate | ovate to oblong | Ovate |
| Pinnae relative sizes | disproportionate | proportionate | proportionate |
| Medial pinnae | remote | remote | overlapping |
| 2nd and distal pinnae incisions | basiscopic | both margins | both margins |
| Pinnae shape | lanceolate-rhombic | ovate to oblong | ovate to obovate |
| Pinnae tip angles | acute | acute to rounded | rounded |

Haufler 1999; Hauk et. al. 2012; Dauphin et al. 2014). To decipher the genetics and origin of *B. michiganense* it is helpful to first consider the relationship of western *B. hesperium* to eastern *B. matricariifolium*.

The allelic composition of western *B. hesperium* supports an ancestry of *B. lanceolatum* (=*B. lanceolatum* subsp. *lanceolatum*) × *B. pallidum*, whereas the allelic composition of eastern *B. matricariifolium* supports an ancestry of *B. angustisegmentum* (=*B. lanceolatum* subsp. *angustisegmentum* (Pease & A.H. Moore) R.T. Clausen) × *B. pallidum*, as shown in Table 2. At six of 20 gene loci tested, these two *Lanceolatae* species differ in alleles present. At five of these six discriminant loci (*Aat-3*, *Aat-4*, *Dia-2*, *Mdh-2*, *Skdh*), it is the *B. lanceolatum* allele that is present in *B. hesperium* (at the 6th discriminant locus, *Dia-4*, no *B.* sect. *Lanceolatae* allele is expressed in *B. hesperium*). *Botrychium matricariifolium* expresses the allele contribution of *B. angustisegmentum* at all six discriminant loci. These parentages also correspond to the western North American sympatric distributions of *B. lanceolatum* with *B. hesperium* and eastern North American sympatric distributions of *B. angustisegmentum* with *B. matricariifolium*.

*Botrychium michiganense* differs from both *B. matricariifolium* and *B. hesperium* in combining the discriminant alleles of both *B. angustisegmentum* and *B. lanceolatum*. At *Mdh-2*, *B. michiganense* consistently expresses the allele of *B. lanceolatum,* whereas at *Dia-4* it consistently expresses the allele of *B. angustisegmentum*. At the other four discriminant alleles (*Aat-3, Aat-4, Dia-2, Skdh*) in different populations throughout its range, *B. michiganense* expresses either the allele of *B. lanceolatum* or the allele of *B. angustisegmentum*. This condition likely reflects multiple origins of *B. michiganense* through hybridizations between the same two ancestral diploid taxa in which an ancestral "*B. lanceolatum*" parent possessed both alleles at these four loci, i.e., the *Lanceolatae* parent of *B. michiganense* may have been an ancestor to both current *B. lanceolatum* and *B. angustisegmentum* that existed prior to the current differentiation of those two species. A "multiple origins" scenario has been demonstrated for other alloploid ferns (Beck et al. 2014; Sigel et al. 2014) and the distributional extension of *B. michiganense* across the ranges of both current taxa is consistent with this hypothesis.

An allozyme survey of the known diploid species of *Botrychium* sect. *Lunariae* (Farrar, unpublished) indicates that *B. pallidum* is capable of having provided the greatest number of non-*Lanceolatae* alleles present in *B. michiganense*. The necessary non-*Lanceolatae* allelic contribution was detected in current populations for 19 of the 20 gene loci analyzed. Only at *Aat-2* is an allele expressed in *B. michiganense* that has not been detected in either *B. pallidum* or any member of the *B.* sect. *Lanceolatae* complex. This allele, *Aat-2*=2, is also present in *B. matricariifolium*, suggesting that it was likely present in *B. pallidum* at the time of the formation of *B. matricariifolium*, which is also thought to be descended from a cross or crosses between ancestral *B. lanceolatum* and ancestral *B. pallidum* (Farrar 2011). Two additional non-*Lanceolatae* alleles are also present in *B. matricariifolium* at *Pgi-2* and *Tpi-1* that have not been detected in extant *B. pallidum*. A simple hypothesis is that ancestral *B. pallidum*, like ancestral *B. lanceolatum*, contained allelic variability not retained in the current taxon. Other hypotheses explaining its allelic composition seem less parsimonious, as no other species share as many alleles.

In summary, the allelic composition of related taxa, based on allelic analysis of gene loci for 20 conservative metabolic enzymes, supports recognition of allotetraploid *B. michiganense* as distinct from both *B. hesperium* and *B. matricariifolium*, based on parentage by a distinct set of diploid parent taxa. This analysis suggests an origin for *B. michiganense* involving hybridization between *B. pallidum* and an ancestral member of "*B. lanceolatum*" genetically different from, and probably ancestral to, the current eastern species *B. angustisegmentum* and the western species *B. lanceolatum*.

## Morphology

The genus community tests show that morphological differences observed between multiple taxa growing at remote locations are retained when they grow in proximity. There are consistent differences between *Botrychium michiganense*, *B. matricariifolium*, and *B. hesperium* (Table 3).

The most consistent characters that distinguish *B. michiganense* are the relative size of the proximal pinnae, and the incision of the non-basal pinnae. Usually, the basal pinna pair is disproportionately elongate in relation to the medial and distal pairs, which are abruptly shorter than the basal pair and then proportionately reduced from one to the next. This character sometimes occurs in *B. hesperium* but is rare in *B. matricariifolium*. The nature of the second degree of dissection is especially apparent in large *B. michiganense* specimens, where incisions that are on medial and distal pinnae are deeper on the basiscopic than on the acroscopic margins; in many average-sized specimens only the basal pinnae and the basiscopic margins of the second pair are incised. When medial and distal pinnae of *B. hesperium* and *B. matricariifolium* are incised, the incisions are equally deep on both the basiscopic and acroscopic margins. Also consistent within *B. michiganense* are the narrowly rhombic-lanceolate, acute and remote pinnae, while *B. hesperium* pinnae are characteristically obovate, obtuse and frequently overlapping. Consistent within many *B. michiganense* are sessile to subsessile trophophores, compared to the distinctive stalked trophophores of *B. matricariifolum*.

We present here a key to *B. michiganense* and sympatric twice-dissected species with which it might be confused.

1. Plants east of the Great Plains, including northern Alberta.
    2. Trophophore sessile or short-stalked to 3 mm, ovate or narrowly ovate; pinnae abruptly reduced in size and cutting from basal to next pair; pinnae above basal pair showing less cutting on acroscopic margins relative to basiscopic margins **B. michiganense**
    2. Trophophore usually stalked, stalk to 10 mm (rarely sessile), ovate to oblong; pinnae gradually and symmetrically reduced from base to apex; if pinnae are dissected, incisions equivalent in depth on both basiscopic and acroscopic margins.
        3. Trophophore broadly ovate, pinnae very broadly ovate and rounded, incised **B. pseudopinnatum**
        3. Trophophore narrowly ovate to oblong; pinnae narrowly to broadly ovate, in some instances not incised **B. matricariifolium**
1. Plants west of the Great Plains.
    4. Trophophore stalk prominent, equal or greater than the distance between the 1st and 2nd pinna pair; trophophore broadly triangular **B. pedunculosum**
    4. Trophophore sessile to short-stalked, narrowly elongate-ovate to broadly ovate.
        5. Sporophore pinnately branched; trophophore lamina lustrous; pinnae always deeply lobed **B. pinnatum**
        5. Sporophore ternately branched; trophophore dull; pinnae simple to lobed (incised).
            6. Trophophore broadly to narrowly ovate, short stalked; basal pinna usually not disproportionately enlarged, ovate to rhombic; medial pinnae usually gradually and progressively diminished in size from base, often slightly to strongly overlapping, broadly ovate to obovate, margins entire to incised and, if incised, then more or less equally so on basiscopic and acroscopic margins, pinna tips rounded **B. hesperium**
            6. Trophophore lanceolate to narrowly ovate, sessile to nearly so; basal pinnae often noticeably longer than medial pinnae, oblong in pinnae with 3 or more pinnules, ovate with margins crenulate to incised in smaller plants; medial pinnae separated, lanceolate to narrowly ovate or oblong, entire or, if crenate or dissected, then more deeply so on basiscopic margins, tips acute or subacute **B. michiganense**

With both allozymes and morphology confirming the distinctiveness of *B. michiganense* as first recognized by Herb and Florence Wagner, we consider it to be a new species of allopolyploid origin, and use the name that Herb suggested.

## TAXONOMY

**Botrychium michiganense** W.H. Wagner ex A.V. Gilman, Farrar, & Zika, sp. nov. (**Figs. 1–3**). Type: MICHIGAN: Grand Sable Dunes, 27–28 Jun 1987, *W.H. Wagner 87228A, F.S. Wagner, Farrar & Hauk* (holotype: NY; isotypes DAO, GH, ISC, MICH, MO, US, WTU).

A *Botrychio hesperio* fronde plus elongo-ovato, pinnatibus basis duobus saepe maiusculis, pinnis mediis remotioribus, atque secundis duobus dissectis basiscopis sed saepe non acroscopis marginibus, differt; a *B. matricariifolio* laminis saepe sessilibus, pinnis angustioribus, et illis sigillis supra enumeratis, differt.

Differing from *B. hesperium* in more elongate-ovate frond, frequently elongated basal pinnae, remote medial pinnae, and pinna-dissection usually confined to the basal pinnae and the basiscopic margin of the second pinna-pair. Differing from *B. matricariifolium* in often sessile to short-stalked trophophore, often elongated basal pinnae, often proportionately narrower pinnae, 0.4× as wide as long (vs. >0.5× as wide as long) and asymmetrical dissection of pinnae above the first pair, with much deeper cutting on the basiscopic side.

**Plants** fibrous-rooted, non-rhizomatous, herbaceous, deciduous, to 5–21 cm tall, distally with two differentiated segments: the foliar, non-sporangiate trophophore with pinnately divided lamina and the non-leafy, ternately much-branched sporophore with numerous sporangia. Proximal **common stalk** 3–15 cm, diameter 1.6–2.5 mm, trophophore and sporophore elevated well above ground. **Sporophore** ca. 3–10 cm, often twice as long as trophophore, with proximal unbranched stalk 0.5–1× as long as trophophore; axis usually (>90%) medially branched with 3 main branches, each with 3+ pairs of additional branches, and these (in large specimens) also with 1+ pairs of additional branches (at most 3 orders of branching); all branches ascending. **Sporangia** approximate but not clustered, broadly attached, globose, 1.0–1.3 mm in diameter, dehiscing by distal transverse slit of ca. one-half the circumference. **Spores** whitish, globose-tetrahedral (38–)41.9(–45) µm diameter. **Trophophore** gray-green to medium green and dull in life, sessile or mostly short-stalked, stalk 0.5–3(–5) mm, ovate to usually (>67%) broadly to usually narrowly elongate-ovate (1–)2–2.5(–3) cm at widest point × (1–)2.5–4(– 5) cm long. Basal pinnae often disproportionately elongated, becoming oblong and parallel-sided, to 1.5–2× as long as next most distal pinnae, the lamina then with an abrupt transition between the first two pinnae pairs from long to short pinnae. **Basal pinnae** usually (always in large specimens) pinnately divided with 3-5 pairs of pinnules, sinuses as deep on acroscopic as on basiscopic margin, elongate-ovate. **Medial and distal pinnae** (2–)3–6(–7) pairs, broadly attached (attachment ca. 0.5× as wide as widest part of pinna), ascending, remote, gradually decreasing in size upwards (distalmost small and approximate or overlapping), elongate-ovate to more frequently narrowly lanceolate-rhombic, (0.35–)0.40–0.44(–0.5) times as wide as long; in most only the second pair incised and then only on basiscopic margin; tips obtuse to usually acute.

*Etymology*.—From Latinized "Michigan," where this taxon was first recognized by Herb and Florence Wagner; referring both to the State of Michigan and to the Great Lakes, originally from Native American Ojibwe meaning "big lake."

*Habitat*.—Habitats supporting *B. michiganense* are typical for moonworts that favor mesic to xeric meadows. Sites are sunny, open areas with sporadic or periodical disturbance sufficient to prevent canopy closure by woody plants. Soils are often calcareous, of neutral reaction, and have minimal organic matter. The overall communities are usually mid-successional or delayed-successional, often with some bare soil still visible, and are often diverse in perennial herbs of whatever species are common in the local area. Other moonworts are often the most faithful associates of *B. michiganense*, likely due to a shared need for myocorrhizal associations with certain glomalean fungi (Winther & Friedman 2007). Moonwort species documented to occur with *B. michiganense* in "mixed genus communities" include *Botrychium ascendens* W.H. Wagner, *B. campestre* W.H. Wagner & Farrar, *B. furculatum* Popovich & Farrar ined., *B. gallicomontanum* Farrar & Johnson-Groh, *B. hesperium, B. lanceolatum, B. lineare* W.H. Wagner, *B. matricariifolium, B. minganense* Vict., *B. pallidum, B. paradoxum* W.H. Wagner, *B. pedunculosum* W.H. Wagner, and *B. simplex* E. Hitchc. Otherwise, there is no general association with any particular herb or herbs across its range, although *Fragaria* L., strawberry, is often present.

Known sites in the western portion of its range include high elevation prairies and pastures, periodically

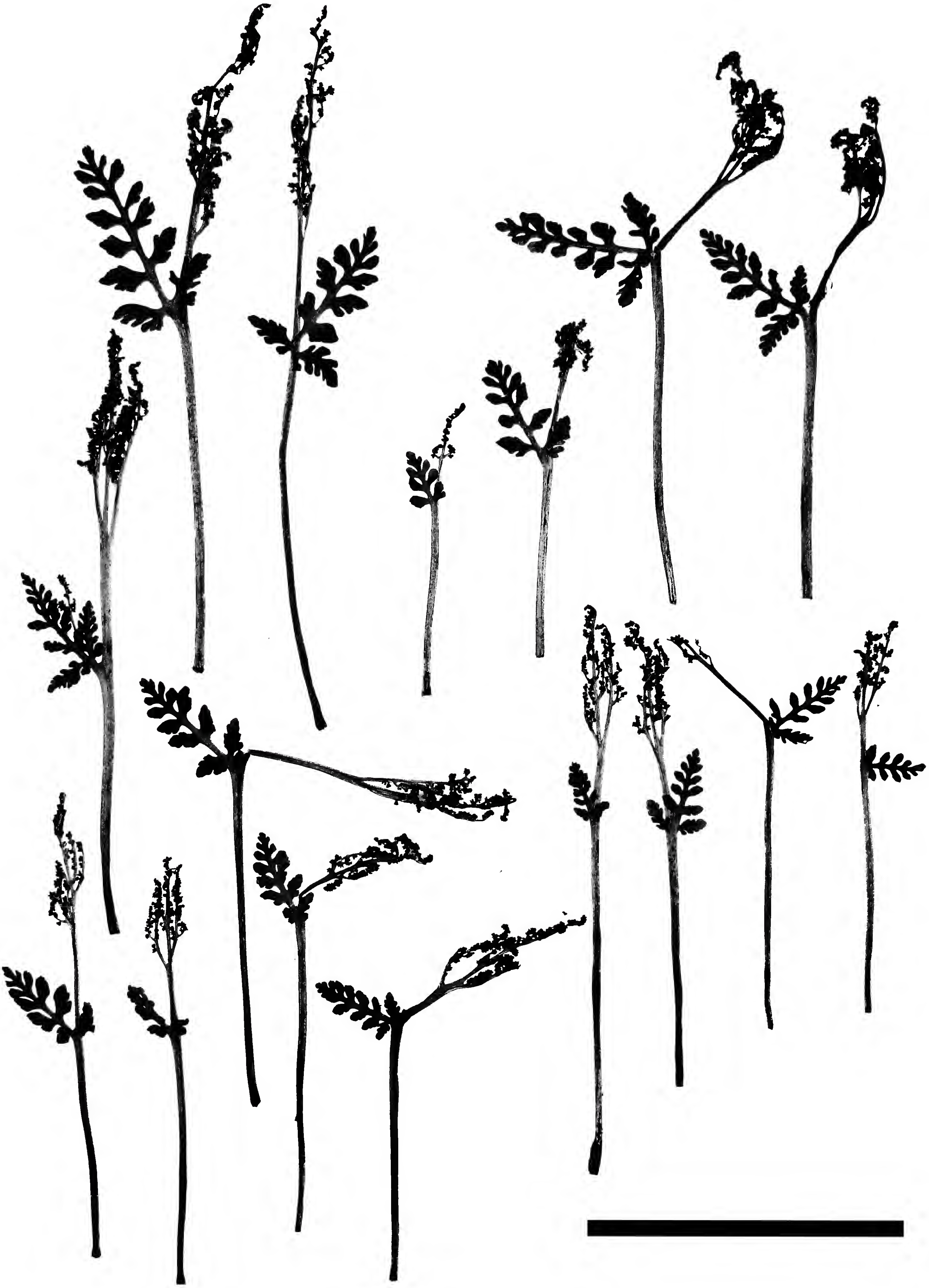


Fig. 1. *Botrychium michiganense*, Holotype, unmounted, *Wagner 87228A, Wagner, Farrar & Hauk* (NY). Scale bar 10 cm.

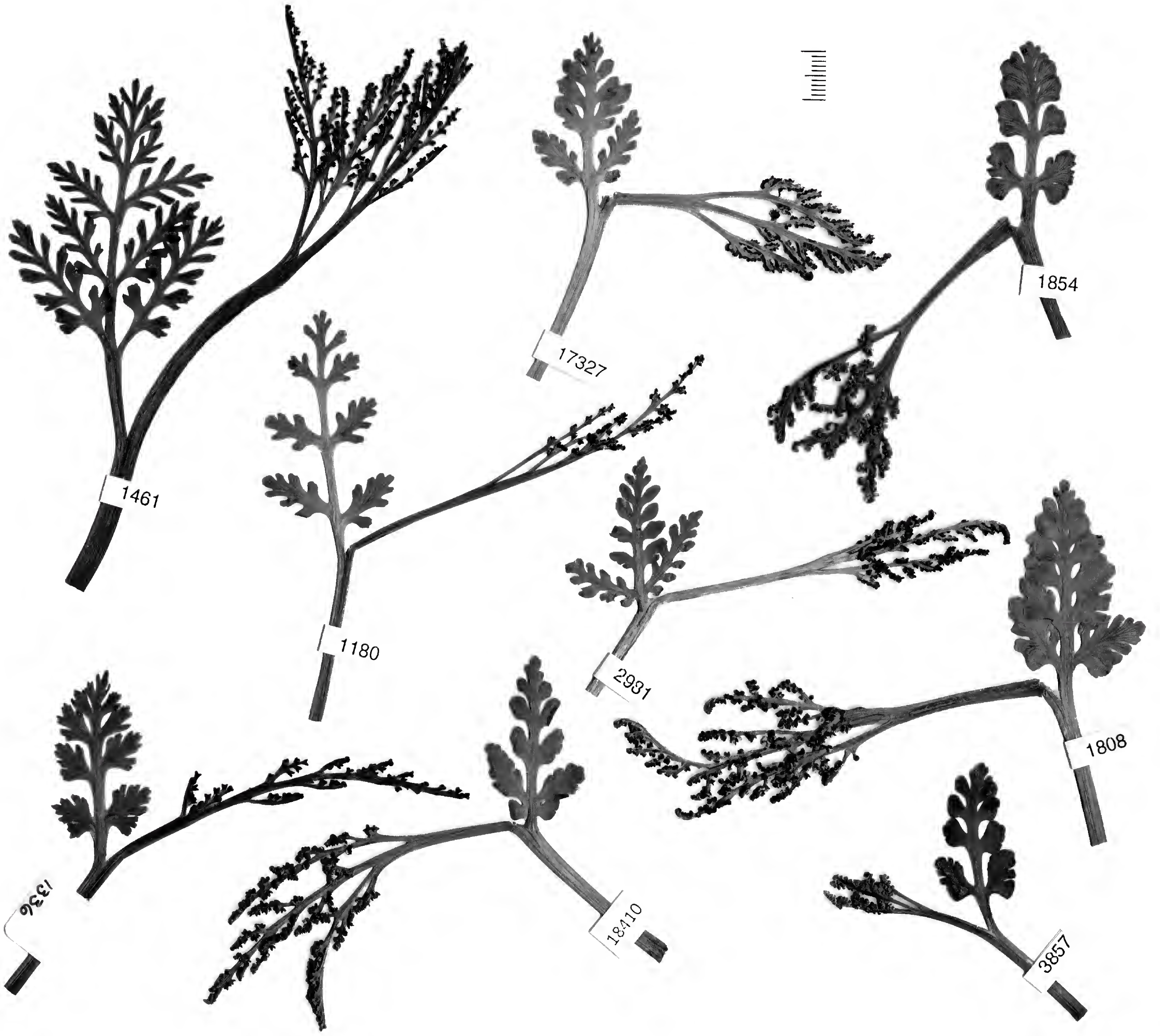
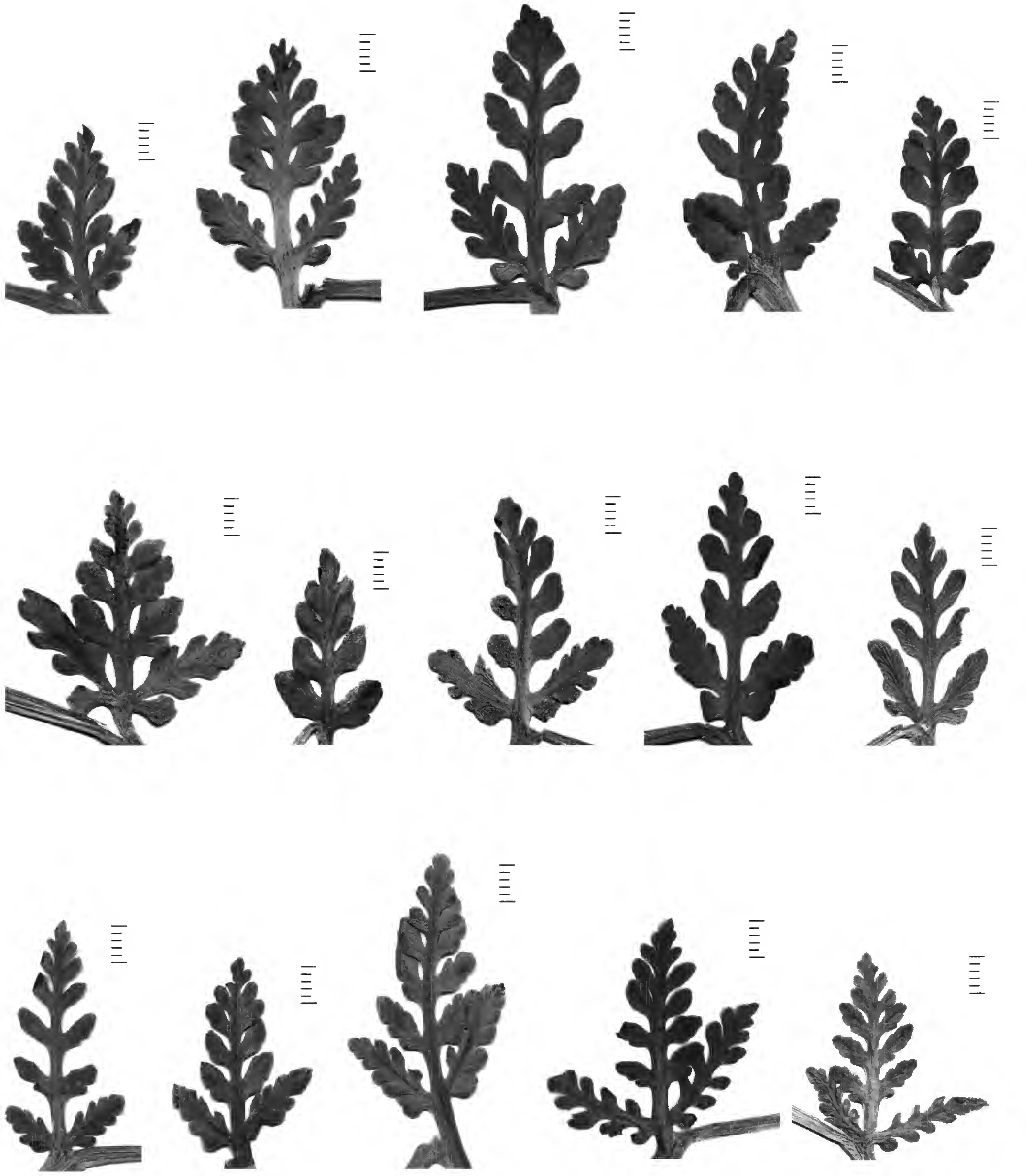


**Fig. 2.** ***Botrychium michiganense*** **compared to** ***B. hesperium*** **and** ***B. matricariifolium*****. Three plants at left (1461, 1180, 1336):** ***B. matricariifolium*****; three at center (17326, 2981, 18410):** ***B. michiganense*****; three at right (1854, 1808, 3857):** ***B. hesperium*****.**

burned sagebrush prairie (the dry extreme of suitable habitats), gravel flats and rarely-flooded river terraces along high-energy rivers, avalanche meadows, ski areas, and abandoned gravel roads and roadcuts. In the Black Hills of South Dakota, *B. michiganense* occurs in open pine and deciduous woodlands and in mountain meadows as well as on roadsides. Eastern habitats include stabilized dune meadows, abandoned settlements, dry fields, maintained clearings along utility lines, roadsides, lawns, and mine-tailings. Altitudinal range in the East is from near sea level to ca. 520 m, in the West from ca. 1500 m to 2600 m or higher, although generally below treeline.

*Distribution.—Botrychium michiganense* is known across North America in several general regions (Figs. 4–6). The easternmost specimens seen are from near the Gulf of St. Lawrence in New Brunswick and along the St. Lawrence River Valley in Québec. It occurs near the northern Great Lakes (Michigan and Superior) and extends westward across northern Minnesota. Within the Great Plains it occurs in the Cypress Hills of Saskatchewan and Alberta, and the Black Hills of South Dakota. West of the Great Plains it occurs on the foothills and in the Rocky Mountains in Alberta and British Columbia, south to Wyoming, Montana, and Washington. The westernmost locales are in the Colville National Forest north of Spokane, Washington. In some areas, including northern Minnesota, the Black Hills National Forest in South Dakota, northwestern



Fɪɢ. 3. East to west morphological variation in *Botrychium michiganense* over its range. **Top row, left to right:** eastern Quebec 16332; northern Michigan 1068, 562, 8264; southern Ontario 17327. **Middle row:** northern Minnesota 14239, 18145; western South Dakota 15027; northern Wyoming 18410, 15018. **Bottom row:** western Montana 2843; eastern Washington 1864, 1873, 2981, 2984. Numbers refer to genetically analyzed specimens (see Additional Specimens Examined). Scale = 1 cm.

Montana, and northeastern Washington, it appears to be a relatively common species. For example the Black Hills National Forest has more than 30 currently known populations (Fig. 6), illustrating the results of dedicated searches in a given area once search images for morphology and habitat are established.

Additional specimens examined.—Note: In addition to the original collector's numbers, some material sent to Farrar's lab received additional numbers [in square brackets], which represent identification numbers of individual plants analyzed for allozyme study.

**CANADA. ALBERTA:** Cypress Hills Provincial Park, SE Corner Hwy 41 & Reesor Lake Road, 9 Jul 2002, *Williston 3764 & Bartemucci*

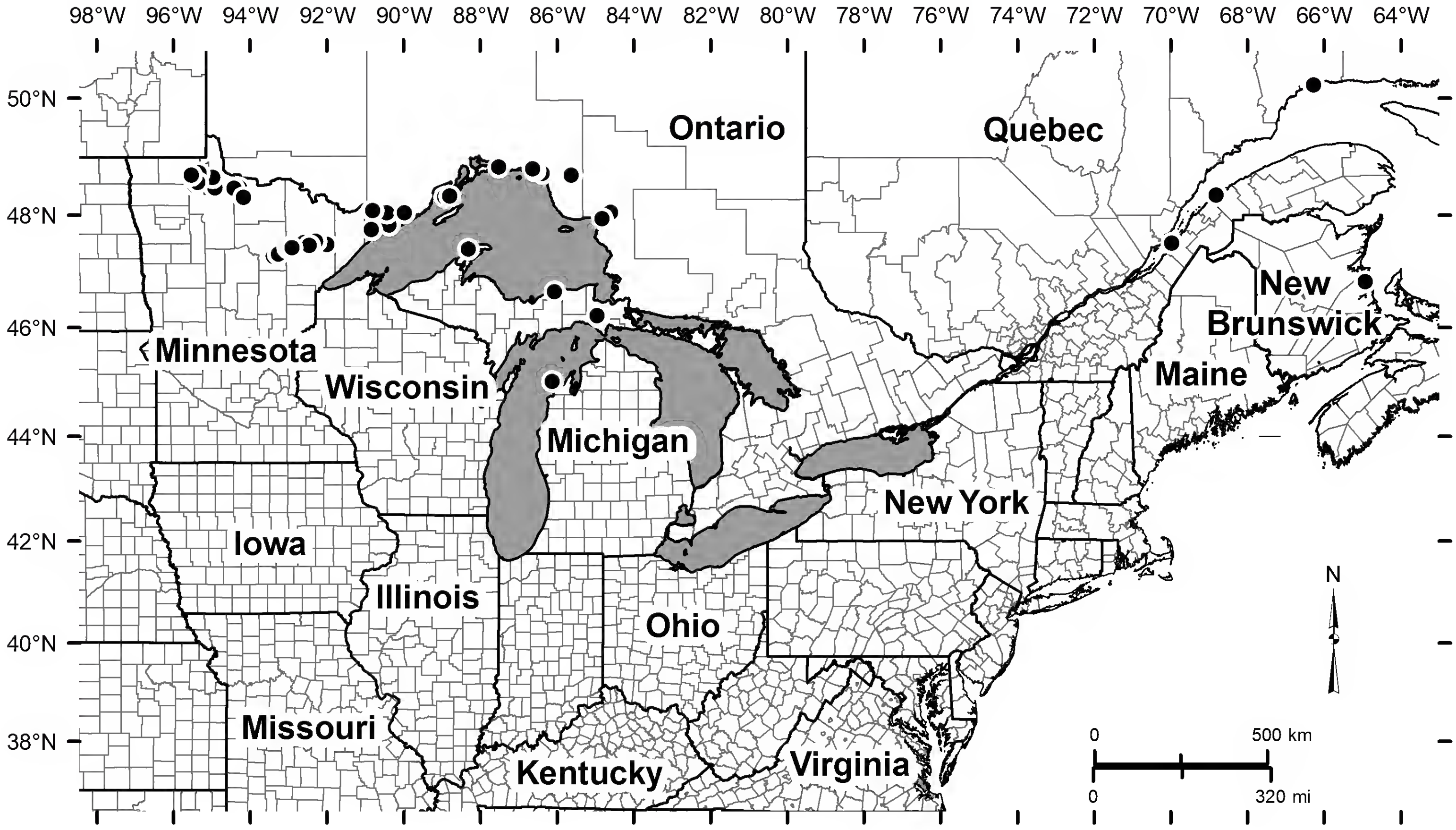


**Fig. 4. Distribution of *Botrychium michiganense* in eastern North America, based on verified herbarium specimens.**

(ALTA). South Drywood Creek, S facing slope, 21 Jul 1999, *Gould, T. Dolman & D. Dolman s.n.* (ALTA). La Butte Creek Wildland Provincial Park, rock outcrop dominated by lichens, 6 Jul 2001, *Vujovnic et al, s.n* (ALTA). Waterton Lakes National Park, S side of Rte. 6 at the Lewis Overthrust Scenic Site parking area, 3 Aug 1983, *Wagner 83318 & Wagner* (MICH); Snowshoe Trail, ca. ⅓ mi NW of Red Rock Canyon parking, large open grassy slope, near pine woods, 5 Aug 1983, *Wagner 83328 & Wagner* [mixed sheet with *B. hesperium*] (MICH). Prospect Creek, Lange Ridge, along trail, open grassy slope, 21 Jun 2008, *Fabijan, Dinwoodie & Anderson 02985* (ALTA). Elk Island National Park, Sand Hills Trail 1, 13 Jun 2005, *Farrar 12122–12125* (ISC); Elk Island National Park, E corner, along old access road kept open by bison grazing, 10 Jun 2001, *Williston 3423, Cotterill & G. Griffiths* (ALTA); Elk Island National Park, Moss Lake Trail, open meadow area, 24 Jun 2001, *Cotterill & G. C. D. Griffiths s.n.* (ALTA). **Athabasca Co.:** Crooked Lake Valley, 28 Jun 2014, *D. E. Griffiths s.n.* (ALTA). **County of Minburn**: Lac La Biche (Birch Lake), 12 Jun 2005, *G. Griffiths s.n.* [=*Farrar 12087–12093*] (ISC); Lac La Biche, Birch Island, shrubby meadow on summit of island, 11 Jul 2007, *T. Maccagno s.n.* (ALTA). **County of Parkland:** Jackfish Lake, 16 Jun 2005, *Farrar 12246, 12247* (ISC); Jackfish Lake, 29 Jul & 18 Aug 2000, *G. C. D. Griffiths s.n.* (ALTA). **BRITISH COLUMBIA. Arrowhead:** Upper Arrow Lake, occasional along gravel road near church, 10 Jun 1958, *Calder 8933 & Savile* (DAO). **NEW BRUNSWICK. Kent Co.:** Kouchibougouac National Park: St. Louis Parish, near Kelley's Beach, 26 May 1977, *Munro 352* (DAO). **ONTARIO. Algoma District:** 2.5 mi W of Wawa, just SE of Algoma Central RR bridge over Rte. 17, 22 Jun 1988, *Wagner 88048 & Wagner* (MICH); W of Siderite Jct. near Wawa, 23 Jun 1992, *Gilman 92070, Wagner & Wagner* (VT); Michipicoten Harbor, near Milmac Mine, sand amongst grass, 12 Jul 1938, *Hosie et al. 981* (DAO). **Thunder Bay District:** Marathon, 21 Jul 2010, *Farrar 18274* (ISC); Neys, south side of railway tracks near Neys Provincial Park, E side of park entrance road, open disturbed meadow, 28 Jun 2009, *Oldham & Brinker 36161* [= Farrar *17327*] (ISC); Sibley Peninsula, crest at head of Thunder Cape, thin soil in exposed locations, 14 Jul 1946, *Garton 1040* (DAO); Sibley Peninsula, Silver Islet, E of Sibley Creek, dry sandy field, 18 Aug 1950, *Garton 1278 & Campbell* (DAO); Sibley Cove, open sandy clearing by old cemetery, 25 Jun 1936, *Taylor, Losee & Bannon s.n.* (GH). **QUÉBEC. Rimouski Co.:** Bic Provincial Park, près du Camp du Cap á l'Orignal, 24 Jun 2001, *Cayouette C8840 et al.* (DAO); same locale, 23 Jun 2008, *Farrar 16332, 16334* (ISC); same locale, 25 Jun 2008, *Farrar 16453* (ISC); Bic Provincial Park, Cap á l'Orignal, terrasse et prairie du haute rivages, sable graveleux et sec, 8 Jul 2008, *Cayouette, Farrar & LaBrecque s.n.* (DAO); Cap á l'Orignal, beach, 6 Jul 1906, *Fernald & Collins 297b* (GH); St.-Denis-sur-Mer, 47°30'34.2"N, 69°57'24.3"W, pelouse, herbaçaie moyenne à basse sur le haut rivage du fleuve St. Laurent, 6 Jul 2008, *Cayouette C9618A* (DAO). **Côte-Nord:** Sept-Îles, Sept-Rivière, aéroport de Sept-Îles, 50°13'15.6"N, 66°15'28.7"W, prairie herbacée, 27 Jun 2009, *Lynch DL09-041B, DL 09-046* (DAO). **SASKATCHEWAN. Cypress Hills:** edge of pine woods, 1 Jul 1947, *Breitung 4188* (DAO). Cypress Hills Provincial Park, Centre Block, W side of road N of Fire Lookout Tower, extensive *Potentilla fruticosa* pastures, 28–30 Jul 1983, *Wagner 83302 & Wagner* (MICH).

**UNITED STATES. MICHIGAN. Alger Co.:** Grand Sable Dunes, open grassy areas and on slopes with shrubs, 25 Jun 1985, *Wagner 85057 & Wagner* (MICH); same locale, 28 Jun 1985, *Farrar 562* (ISC); same locale, 21 Jun 1995, *Farrar 1058* (ISC); shady woods in and around Lakeshore Trail, 1–2 September 1985, *Wagner 85073A & Wagner* (MICH); in jack pines, shade form, 21 Jun 1986, *Wagner 86042 & Wagner* [mixed sheet with *B. matricariifolium*] (MICH); 1.4–2.0 mi from beginning of Lakeshore Trail at Grand Sable Lake, 22 Jun 1986, *Wagner 86045 & Wagner* [mixed sheet with *B. matricariifolium*] (MICH); just N of Sable Lake, 22 Jun 1993, *Gilman 93090, Wagner & Wagner* (VT).

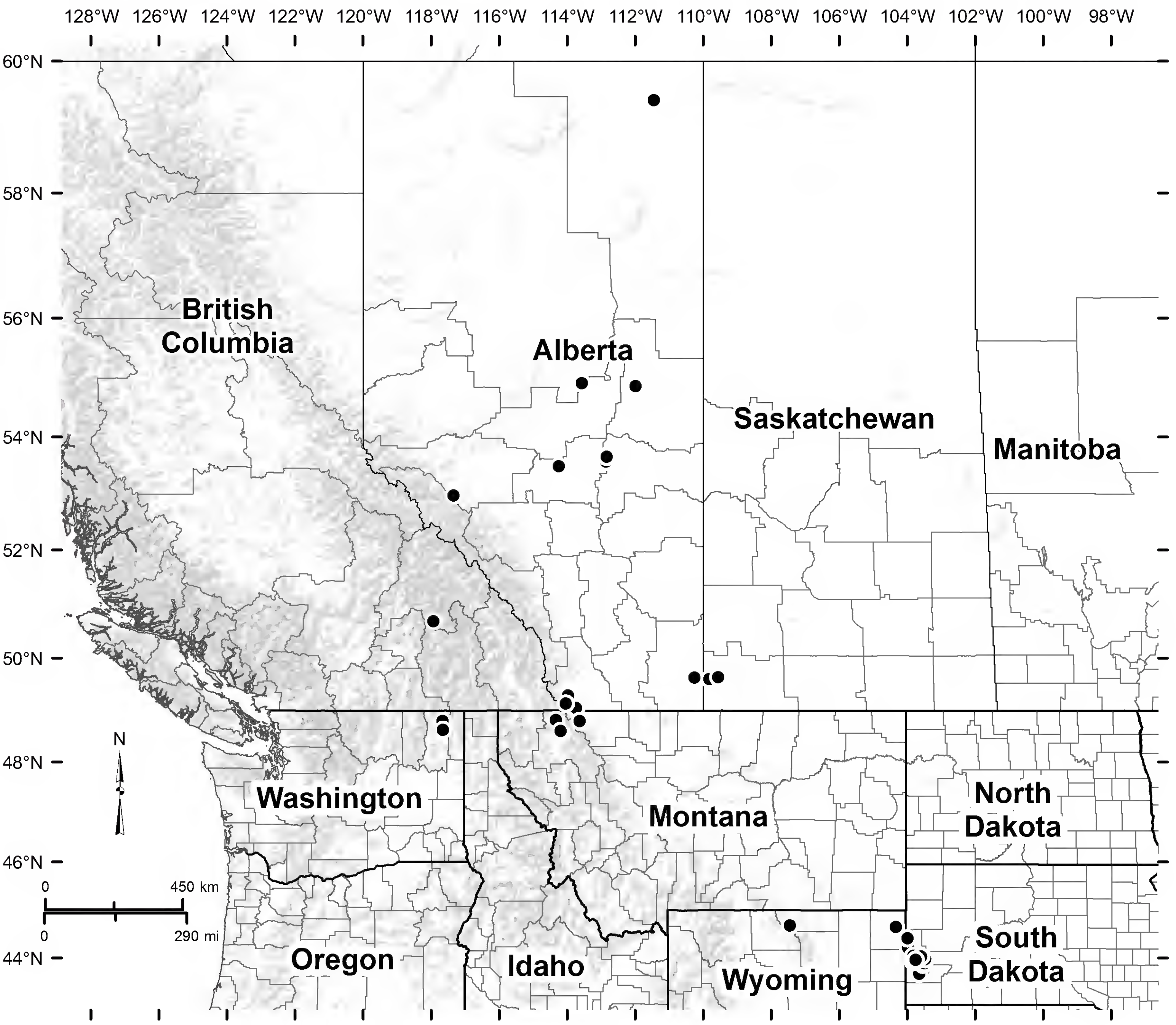


**Fig. 5. Distribution of *Botrychium michiganense* in western North America, based on verified herbarium specimens.**

**Chippewa Co.:** Forestry Road 3139 and railroad crossing, 10, 17 Jun 1988, *Wagner 88014, 88016.5 & Wagner* (MICH); Bobbygay Lake Road near Trout Lake, 14 Jun 1994, *Gilman 94051, Wagner et al.* (VT); Bobbygay Road, 19 Jun 2003, *Jaunzems s.n.* [= *Farrar 8264*] (ISC). **Leelanau Co.:** S. Manitou Island, Garden City area, field, 12 Jun 1985, *Wagner 85038A & Wagner* (MICH). **MINNESOTA. Cook Co.:** Sawbill Camp, 29 Jun 1998, *Farrar 2921, 2922, 2923* (ISC); T61N R4W S8NENWNW, Superior National Forest, Sawbill CCC Camp, 12 Jul 2004, *Gerdes & Lawson 618* (MIN); T62N R1E S30 SWNW, Grand Marais Seaplane Base, NE shore of Devil Track Lake, 16 Jun 2007, *McFarlane et al. 9* (MIN); T64N R01W S10SWNE, Superior National Forest, 0.6 mi NE of Clearwater Lake, 18 Jun 1998, *Gerdes 2753* (MIN); T64N R03E S12NENWS, Superior National Forest, NE of Grand Marais, S Fowl Lake Cliff, 16 Jun 2005, *Gerdes et al. 5092* (MIN); T65N R04W S27NWSE, Superior National Forest, Cross River area, FR 320, 7 Jun 1998, *Gerdes 2629* (MIN); T65N R04W S26SENE, Superior National Forest, edge of old gravel pit and slash burn area, 10 Jul 1999, *Gerdes 3556* (MIN); Pancore Lake, 11 Jul 2003, *Greenke s.n.* [= *Farrar 8667–8670*] (ISC). **Itasca Co.:** T56 R24 NE ¼ of NE ¼ of Sec 34, taconite tailings basin S of Holman, 30 May 2001, *Dahl, Engels & Butler 01006, 01007, 01009* [= *Farrar 4926–4928, 4931, 4937–4940, 4942–4944, 4946, 4947*] (ISC); taconite tailings basin 2 mi SE of Bovey, 21 Jul 1999, *Dahle, Engels & Butler s.n.* [= *Farrar 4078*] (ISC). **Koochiching Co.:** Pine Island State Forest, Pine Island Forest Road, N side, SWSW of section, 6 Jun 2011, *MacFarlane & MacFarlane 182* (MIN); Pine Island State Forest, Indian Pines Forest Road, N side, NESE of section. 5 Jun 2011, *MacFarlane & MacFarlane 166* (MIN). **Lake of the Woods Co.:** T160N R34W SWSE34, Beltrami Island State Forest, Nelson Forest Road at State Forest Road 1181, 6 Jun 2010, *MacFarlane 138* [mixed sheet] (MIN); Beltrami Island State Forest, Bankton Forest Road, 8 Jun 2012, *MacFarlane 347* (MIN). **Roseau Co.:** Beltrami Island State Forest, Penturen Forest Road, old homestead SESE of Section, 19 Jun 2011, *MacFarlane & MacFarlane 267* (MIN). **St. Louis Co.:** T57N R20W NE SE 32, mine dump E of Hwy 69, 0.5. N of Kitzville, 5 Jun 2007, *MacFarlane et al. 25* (MIN); T58N R19W SW SW 32, 2 mi S of Buhl, N of Hayes Rd., 1 Jul 2006, *MacFarlane et al. 19* (MIN); Superior National Forest, T58N R18W NE NW 28, Skibo Landing, NE side of railroad tracks, 30 Jun 2006, *MacFarlane et al. 20* (MIN); T58N R15W NE NW 28, mine dump E of Hwy 138 to Giant's Ridge, 6 Jun 2007, *MacFarlane et al. 30* (MIN); T58N R15W SW SW 2, on a mine dump ca. 0.5 mi E of Aurora, 8 Jun 2008, *MacFarlane et al.*

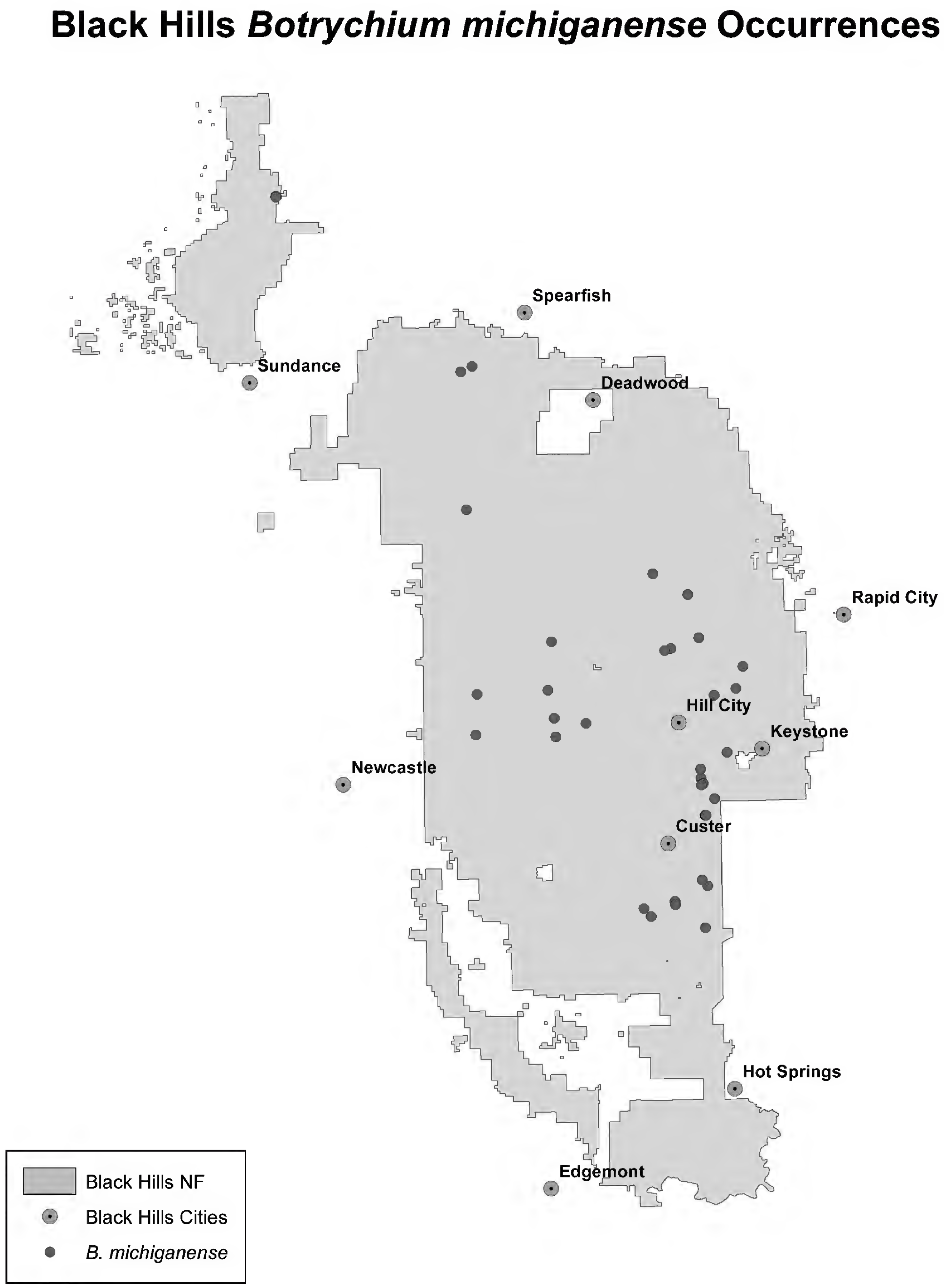

Black Hills *Botrychium michiganense* Occurrences
Spearfish
Sundance
Deadwood
Rapid City
Hill City
Keystone
Newcastle
Custer
Hot Springs
Edgemont
Black Hills NF
Black Hills Cities
*B. michiganense*

Fig. 6. Occurrence of *B. michiganense* in the Black Hills National Forest. Map reflects ten years of rare plant search by the Black Hills NF staff, beginning with a single population discovered in 2002. Map courtesy of Cheryl Mayer, Botany Technician, Forest Service, Black Hills NF.

*70* (MIN); T57N R21W NW NW 15, on top of a mine dump W of Highway 60 & 63 intersection between Kelly Lake and Leetonia, 16 Jun 2007, *MacFarlane et al. 42* (MIN); same locale, 7 Jun 2008, *MacFarlane et al. 74* (MIN); T58N, in iron ore tailings basin, Off-Highway Vehicle Recreation Area E of Gilbert, 30 Jun 2004, *Dahle et al. 4038* (MIN) [=*Farrar 14329*] (ISC); Hibbing, 30 Jun 2005, *Dahle et al. s.n.* [= *Farrar 12595–12602*] (ISC); taconite tailings ca. 1 mi E of Hibbing, 23 Jun 1999, *Dahle et al. 99009* [= *Farrar 3610, 3611, 3612, 3613, 3614, 3617*] (ISC); taconite tailings 2 mi W of Hibbing, 23 Jun 1999, *Dahle et al. 99008* [= *Farrar 3581–3586*] (ISC); Gilbert, 24 Jun 2003, *Dahle s.n.* [= *Farrar 8209*] (ISC); Kelley Lake, 9 Jun 2008, *Farrar 16078* (ISC); Markmanship Road, 19 Jul 2010, *Farrar 18144* (ISC). **MONTANA. Flathead Co.:** Glacier National Park, S end of Big Prairie [Big Meadow], elev. 3600 ft, NE of North Fork Flathead River, E of Inside Road, T35N R21W S16, c. 48°49'N, 114°19'W, 20 Jun 1998, *Wagner 98016 & Wagner* (MICH); same locale, 14 Jul 2000, *Larsen & Larsen 4551–4554, 4557–4559* (ISC); north end of Great Northern Flats, elev. 3300 feet, E side of Forest Service Road 486, W side of North Fork Flathead River, Flathead National Forest, T33N R20W S35, 20 Jun 1998, *Wagner 98023 & Wagner* (WTU); same locale, 20 Jun 1998, *Gilman 98043, Wagners, Zika, Lesica & Forest Service botanists* (VT); same locale, 19–20 Jun 1998, *Farrar 2840–2844* (ISC); Fire History pulloff on Rte 486, S of Polebridge, 20 Jun 2005, *Farrar 12393–12397* (ISC). **Glacier Co.:** a few meters from north shore of west end of Lake Sherburne Reservoir on Swiftcurrent Creek, Apikuni Flat, elev. 4800 feet, T35N R16W S12, 21 Jun 1998, *Zika 13434 & W.H. Wagner* (WTU); same locale, 19–20 Jun 1998, *Farrar 2884–2888, 2912, 2913, 2915–2917* (ISC). **SOUTH DAKOTA. Custer Co.:** Black Hills National Forest, Rocky Road, 30 May 2007, *Mergen 06VO35–36* [= *Farrar 14265–14267*] (ISC); Custer State Park, Cathedral Spires, 22 Jun 2011, *Mayer 1403* [= *Farrar 18725*] (ISC); Bowman, 24 May 2008, *Mergen 08CO08B* [= *Farrar 16048*] (ISC); Bowman, below old road of old burn, 29 May 2008, *Mergen 08CO23A* [= *Farrar 16109–16111*] (ISC); Bowman, old burn, 5 Jun 2008, *Mergen 08CO28D* [= *Farrar 16114*] (ISC); Star, open slope, 21 Jun 2008, *Mergen 08SO17D* [= *Farrar 16566*] (ISC). **Lawrence Co.:** Black Hills National Forest, Eagle Cliffs, 19 Jun 2009, *Farrar 17139* (ISC). **Pennington Co.:** Black Hills National Forest, Pine Creek, 16 Jun 2008, *Mayer s.n.* [= *Farrar 16126*] (ISC); Calumet, 3–8 Jun 2009, *Mergen 09CO10C* [= *Farrar 17110, 17111, 17141*] (ISC); Windmill, 26 Jun 2008, *Mergen 08WO02A* [= *Farrar 16567*] (ISC); Harney Peak Trail, 17 Jun 2007, *Farrar 18093, 18094, 18110* (ISC); Hat Mountain, 21 Jun 2011, *Farrar 18592* (ISC); Reynold's Prairie, 16 Jun 2009, *Farrar 17119* (ISC); Pactola, 10 Jun 2009, *Mergen 09PO07A* [= *Farrar 17143*] (ISC); Sixmile Draw, no date, *Mayer 1400* [= *Farrar 18724*] (ISC); same locale, no date, *Mayer & Burkhart s.n.* [=*Farrar 15027*] (ISC); same locale, no date, *Mergen 09PO07A* [= *Farrar 15320*] (ISC). **WASHINGTON. Stevens Co.:** Colville National Forest, Paradise Meadow, T38N, R41E, S15, 26 Jun 1997, *Farrar 1863–1877* (ISC); same locale, 14 Jun 2002, *Ahlenslager s.n.* [= *Farrar 6329–6333, 6334–6338*] (ISC); same locale, 24 Jul 2005, *Legler 2868, 2869* (WTU); same locale, 30 Jun 1996, *Larson 209* (WTU); Colville National Forest, Bestrom Meadow, T36N R41E S19, 30 Jun 1997, *Ahlenslager s.n.* [= *Farrar 1910–1917*] (ISC); same locale, 7 Jul 1998, *Farrar 2981–2989* (ISC). **WYOMING. Crook Co.:** Black Hills National Forest, Bear Lodge Campground, T54N R62W S20, 8 Jun 2004, *Farrar 5015–5019* (ISC); same locale, 16 Jul 2002, *Farrar 6381* (ISC); same locale, 6 Jun 2007, *Corey BLGC-A* [=*Farrar15019*] (ISC). **Sheridan Co.:** Big Horn Mountains: Pole Creek Road, 17 Aug 2010, *Farrar 18410* (ISC).

### APPENDIX 1

Number of *Botrychium* specimens analyzed for allozyme composition. NP = National Park.

| Collection sites | *B. michiganense* | *B. hesperium* | *B. matricariifolium* |
|---|---|---|---|
| **Canada** | | | |
| Alberta – Birch Lake, Elk Island, Jackfish Lake | 9 | | 21 |
| Ontario – Lake Superior north shore | 14 | | 11 |
| Quebec – Bic NP, Kamarouska, St. Denis | 13 | | 21 |
| **United States** | | | |
| Colorado – multiple sites | | 35 | |
| Minnesota – multiple sites | 10 | | 17 |
| Montana – Glacier NP, Flathead Lake | 6 | | |
| New Mexico – Vermejo Ranch | | 2 | |
| South Dakota – Black Hills, multiple sites | 37 | | |
| Wyoming – Black Hills, Bear Lodge Mts. | 6 | | |
| **Total** | 95 | 37 | 70 |

### APPENDIX 2

*Botrychium* specimens inspected for genus community comparisons.

**Botrychium hesperium**

Colorado: Grand Co.: Winter Park, JK Ski Run, *Farrar 14490–14501* (ISC)—11 specimens.
Montana: Flathead Co.: Great Northern Flats, *Farrar 2837, 2838, 2839* (ISC), *Zika 13432* (WTU)—13 specimens.
Montana: Glacier Co.: Glacier National Park, Big Prairie, *Zika 13439* (WTU); *Farrar 2845–2849; 2903–2907* (ISC)—21 specimens.
Washington: Stevens Co.: Bestrom Meadow, *Farrar 2999–3013* (ISC); *Farrar 6357–6379* (ISC)—38 specimens.

**Botrychium matricariifolium**

Michigan: Alger Co.: Grand Sable Dunes: *Farrar 870627A, 876027B, 870627B-1, 870627B-2* (all ISC)—26 specimens.
Vermont: Caledonia Co.: *Gilman 04026* (VT)—29 specimens.

**Botrychium michiganense**

Michigan: Alger Co.: Grand Sable Dunes: *W.H. Wagner 87228A, F. S. Wagner, Farrar, & Hauk* (MICH, GH, NY, DAO UC, US. ISC, VT, WTU, MO, CAN, MONTU)—47 specimens.

Montana: Flathead Co: Great Northern Flats: *Gilman 98043 et al.* (VT)—10 specimens.

Montana: Glacier Co.: Glacier National Park: Big Prairie: *Wagner 98106 & Wagner* (MICH); *Larsen & Larsen 4551–4554, 4557–4559* (ISC)—16 specimens.

Washington: Stevens Co.: Bestrom Meadow: *Farrar 1910–1917, 2981–2989* (ISC)—17 specimens.

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# BOOK REVIEW

E. Charles Nelson & David J. Elliott. 2015. **The Curious Mister Catesby.** (ISBN-13: 978-0-8203-4726-4, hbk). University of Georgia Press, Main Library, Third Floor, 320 South Jackson Street, Athens, Georgia 30602, U.S.A. (**Orders:** www.ugapress.org, 1-800-266-5842). $49.95 US, 456 pp., 238 paintings/illus./photos/maps, 8" × 11".

Meticulous research and high-quality illustrations make *The Curious Mister Catesby* a comprehensive resource bound to appeal to a wide audience. The book paints a portrait of the botanical world during Mark Catesby's life and in doing so, guides the reader in recognizing his exceptional talent.

Far from a straight-forward biography, the book is the work of nearly two dozen authors of various disciplines, including anthropologists, historians, zoologists, botanists, and more. Every chapter analyzes Catesby's work from a different angle, yet each author's perspective blends seamlessly with the next. The authors build a detailed story of Mark Catesby's life and times, which is especially impressive considering the lack of historical documents about him as an individual. Herbarium labels, governmental records, diaries of Catesby's contemporaries, and other far-reaching resources track the course of his work.

Rife with high-quality illustrations—including etchings, herbarium specimens, paintings, maps, historical documents, and modern photographs—*The Curious Mister Catesby* is suitable for both leisurely reading and scholarly studies. The thick, large pages and sturdy binding make the book exceptionally easy to read, and the plethora of illustrations are captivating. Although I appreciate the variety of illustrations, I would like to see more of Catesby's work, especially considering his artistic reputation.

*The Curious Mister Catesby* also includes chapters about Mark Catesby's forerunners and contemporaries and their influence on both him and natural history as a whole. Most notably discussed are Maria Sibylla Merian, whose artistry Catesby is thought to have admired, and William Dampier, whose dedication and thoughtful recordings of nature were not unlike Catesby's.

Mark Catesby owes his great success in North America to a combination of his natural talent and ambition and a powerful network of supporters who appreciated his passion for nature. That passion and talent seeps through the pages of *The Curious Mister Catesby*, illuminating the man whose tireless excursions and keen observations led to one of the most important publications of flora and fauna of the New World.—*Alyssa Young, Botanical Research Institute of Texas, Fort Worth, Texas, U.S.A.*

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# NOTES ON *ERITRICHIUM* (BORAGINACEAE) IN NORTH AMERICA II

David F. Murray

*University of Alaska Museum of the North*
*907 Yukon Drive*
*Fairbanks, Alaska 99775-6960, U.S.A.*
*dfmurray@alaska.edu*

## ABSTRACT

The common, widespread *Eritrichium* of the Rocky Mountains is *E. argenteum*; the importance of the Asian *E. sericeum* s.l. to the North American flora is noted; minor issues relating to the type for E. *splendens*, the treatment of *E. chamissonis*, and the disposition of *E. howardii* are given.

## RESUMEN

El común *Eritrichium* de las Montañas Rocosas es *E. argenteum*; La importancia del asiático E. sericeum s.l. en la flora norteamericana es notable; se aportan cuestiones menores relacionadas con el tipo de E. splendens, el tratamiento de *E. chamissonis*, y la disposición de *E. howardii*.

The purpose of the notes that follow is to provide background information that is more than can be accommodated in comments sections of species accounts in *Flora of North America north of Mexico.* Additionally, prior to the appearance of *Eritrichium* in Volume 15, nomenclatural issues have to be settled (cf., also Gandhi & Murray 2013 and Murray 2013).

### 1. A name for the common, widespread Rocky Mountain *Eritrichium*

Aside from the very distinct *Eritrichium howardii* (A. Gray) Rydb. the alpine forget-me-not of the Rocky Mountains was initially named using combinations derived from earlier work in the Arctic: e.g. *E. aretioides* (Cham.) DC, *Omphalodes nana* var. *aretioides* (Cham.) A. Gray. Rydberg (1900), with *E. aretioides* var. *elongatum* Rydb., provided the first recognition there might be an entity distinct from *E. aretioides*, perhaps, he commented, at the rank of species, but which he published as a variety.

Wight (1902) reviewed the North American taxa, and he noted that the nutlets of Rydberg's var. *elongatum* have smooth margins, whereas some of the material at hand included specimens with nutlets having toothed margins and different features of leaf indumentum. This he named *E. argenteum* W. Wight. He then raised var. *elongatum* to species rank, and in so doing created a later homonym of *E. elongatum* (A.DC) A.DC. Wight made the different types of nutlets the primary dichotomy in his key to species and thus did not work out whether other characteristics of the two taxa showed a parallel discontinuity. Wight's taxonomy was used by Rydberg (1906) and Coulter and Nelson (1909) in what must have been widely used manuals of their day.

Macbride (1916) believed that the nutlet differences proposed by Wight (1902) to be constant and therefore good specific characters. Johnston (1924) used the same basic dichotomy of nutlet morphology as Wight, but treated those plants with toothed margins as distinct only at the varietal level and published the combination *E. elongatum* var. *argenteum* (W. Wight) I.M. Johnst., noting that it was a taxon of the more southern portions of the range of "*elongatum.*" This is the taxonomy followed by Harrington (1954).

Years later (1952) Johnston, when commenting on specimens from the Uinta Mountains of Utah received from Payson, wrote that he saw these as indistinguishable from the "uncommon" var. *argenteum*, hinted that they might rise to the rank of species, but ultimately used this material as the basis for *E. elongatum* var. *paysonii* I.M. Johnst.

Cronquist (1959) held the view that, with the exception of *E. howardii,* all the Rocky Mountain variation of *Eritrichium* fell within the limits of *E. nanum* var. *elongatum* (Rydb.) Cronq., He also recognized *E. nanum* var. *aretioides* (Cham.) Herder, but not in the Rocky Mountains.

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Macbride (1916) had noted the similarity of American plants to *E. nanum* of Europe and described a difference in the flange of the nutlets, which Johnston (1924) was unable to see. Johnston did remark that the North American material was to him more canescent that *E. nanum*.

Lechner-Pock (1955–1956), who was familiar with *E. nanum* through her monographic study of *Eritrichium*, treated *E. nanum* as European and distinct from all taxa she knew from North America. In the first couplet of the key on page 103 of her monograph, Lechner-Pock pointed out that the morphology of the ventral surface of the nutlets of the two European taxa, *E. nanum* and *E. jankae* Simonkai (*E. nanum* subsp. *nanum* and *E. nanum* subsp. *jankae* in the treatment of Chater1972) differ in the position of the attachment of each nutlet: at the lower 1/3 versus at the base. This is because the nutlet of *E. nanum* is enlarged below the attachment, creating a sac-like form, a feature absent from the North American plants (is this the distinct spreading border or flange of Macbride?). She illustrated these differences (p. 117, figs. 14–19 for *E. nanum*, p. 119, contrasting figs. 49–54 for *E. "aretioides"*). Therefore, the name *E. nanum* is misapplied to North American plants.

Cronquist (1984) wrote that the Rocky Mountain plants are "much like var. *nanum* except in being usually more densely hairy; a small difference in the form of the nutlets has been alleged." He went on to say, "Plants of var. *elongatum* from the northern Rocky Mountains (including the type) have the flange of the nutlets entire, but many of those from the southern Rocky Mountains have the flange evidently lacerate-toothed with segments up to about 0.5 mm long." He continued, "These more southern plants with lacerate-toothed nutlets have often been treated as a distinct species, variety, or form (*argenteum*). Although the nutlets provide many useful taxonomic characters in the Boraginaceae, in this instance the difference does not appear to be significant. Plants with the flange entire occur throughout the range of the *argenteum* phase, without any other obvious differences." For more than 50 years the Rocky Mountain specimens have mostly been named *E. nanum* var. *elongatum*, following Cronquist's taxonomy. Weber (1967 and in all subsequent editions and revisions of his floras) named the Colorado plants *E. aretioides*, but this taxonomy was not widely followed.

The type specimens for *Eritrichium argenteum* (US!) and *E. elongatum* (NY!) are sufficiently different from each other that one can conclude, at least at this starting point, that there are two taxa. Problems arise when determining a large selection of specimens. The forms of the nutlets while expected, *a priori,* by Macbride (1916) and initially by me, to be consistent within taxa were not. Therefore various aspects of leaf indumentum must be evaluated. Having done that, I conclude that the two type specimens represent extremes of a spectrum of variation. When many specimens are examined, they do fall into two piles representing an *argenteum* form and an *elongatum* form, but with a third pile of intermediates that can only be assigned arbitrarily to one or the other pile. If one accepts there is one highly variable species in the Rocky Mountains, then at the rank of species, the correct name is *E. argenteum* W. Wight.

**Synonymy**

*Eritrichium elongatum* var. *argenteum* (W. Wight) I.M. Johnston
*Eritrichium elongatum* var. *paysonii* I.M. Johnston
*Eritrichium nanum* subsp. *villosum* var. *villosum* f. *argenteum* (W. Wight) Brand
*Eritrichium aretioides* var. *elongatum* Rydb.
*Eritrichium nanum* var. *elongatum* (Rydb.) Cronq.
*Eritrichium elongatum* (Rydb.) W. Wight [a later homonym of *E. elong*atum (A.DC] A.DC.

The next question arising is whether *Eritrichium argenteum* is distinguishable from *E. aretioides*. The two species are geographically well separated; however, Wight (1902) and Cronquist (1959) both noted the similarity of *E. argenteum* to *E. aretioides*, citing only dfferences in the length of the teeth on the flange of the nutlets to distinguish them. Nevertheless, on the strength of these features Cronquist (1959) did maintain as a distinct entity *E. nanum* var *aretioides* (Cham.) Herder. I find that conspicuously pustulate leaves of *E. aretioides*, nutlets with longer teeth, and, of ourse, geography separate the Alaska-Yukon material as *E. aretioides*. Additionally, in a preliminary molecular study, A. Tribsch (pers. comm.) found that *E. argenteum* is well separated by genetic markers from *E. aretioides*.

## 2. Asiatic origins for species of *Eritrichium* in North America

There is more variation in boreal and arctic species of *Eritrichium* in North America than previously reported. Most of the species found in North America show Asian connections through morphology and distribution. The Asiatic influence is not surprising, inasmuch as throughout the Tertiary, until the late Miocene flooding of the Bering Strait, and several times in the Quaternary during glacial maxima and lower sea levels, the exposed Bering Land Bridge provided a dry land connection between Asia and America. During those times Alaska and Yukon were physically and biotically an extension of Asia, isolated from the rest of North America by Quaternary ice sheets.

Thus it is not unexpected that *Eritrichium villosum* (Ledeb.) Bunge, a common tundra species on the Chukotka Peninsula and westward in Russia, is now known in North America from St. Lawrence Island in the Bering Strait region of Alaska: vicinity of Savoogna based on *Carlson 2012-141* (UAAH !) and Boxer Bay based on *Young1313* (GH!) [reported in Young (1971) as *E. aretioides*]. Its closest morphological relatives in North America are *E. aretioides* and *E. chamissonis* from which *E. villosum* is distinct.

*Eritrichium splendens* Kearney ex W. Wight is endemic to Alaska and Yukon and morphologically in sharp contrast with its primary congener, *E. aretioides,* most visibly by its leaf indumentum consisting of stout, strigose hairs appressed and aligned toward the apex of the leaves, as is typical of the *E. sericeum* s.l. complex as elaborated by Ovchinnikova (2001, 2008) in her study of the Asian members.

Johnston (1924) and then Hultén (1948) pointed out the similarity of *E. splendens* of Alaska to the Central Asian *E. rupestre* (Pallas) Bunge (=*E. altaica* Popov) and also to *E. pectinatum* (Pall.) DC., which is found further eastward in Siberia, all belonging to the *E. sericeum* s.l. complex. Gjaerevoll (1967) also compared his collection of *E. splendens* from Alaska with *E. rupestre* and concluded that the two species were distinct. Scoggan (1979), on the other hand, named our plants *E. rupestre* with *E. splendens* in synonymy.

Ovchinnikova (2001, 2008) included *E. splendens* in her reviews of *E. sericeum* s.l., thus she recognized its overall similarity to what she has studied in northeastern Asia, but she maintained *E. splendens* distinct from the Asian taxa at the rank of species. *Eritrichium splendens* should be regarded as but one taxon in a complex of similar entities in Asia and America for which the stout, strigose hairs are a defining feature.

As collections of *Eritrichium* with strigose hairs appeared in herbaria they simply had been filed with *E. splendens*. Specimens accumulated to the point it become clear that there was more than just *E. splendens* to be understood. Examination of these specimens led to the recognition of *E. arctisibiicum* (V.V. Petrovsky) Khokhr. (*E. sericeum* var. *arctisibiricum* V.V. Petrovsky), new to North America.

*Eritrichium arctisibiricum* is now known from a locality on the Porcupine River in the boreal interior of Alaska, at three localities in arctic Alaska, on the Shaviovik River, at Prudhoe Bay, and at Atqasuk (Meade River) and also in northwestern Yukon. The original description by Petrovsky was based on specimens from Wrangel Island, but he mapped it as occurring elsewhere, especially in the arctic European Russia. (cf. Petrovsky 1980). The strigose hairs on the leaves are finer than those on *E. splendens*, but appressed and with strict orientation toward the leaf apices. The clear differentiation of oblanceolate blade and narrow petiole is a distinguishing feature of *E. arctisibiricum* as opposed *E. splendens*, which shows almost no discontinuity between blade and petiole.

## 3. Clarification of minor points with respect to the holotype for *Eritrichium splendens* Kearney ex W. Wight

There are minor discrepancies between what is on the label of the type specimen for *Eritrichum splendens* at US and what was published by Mendenhall (1902) with respect to both the collector and date of collection. The specimen was not collected by Mendenhall as had been written on the specimen label. As Hultén (1940) pointed out, the type specimen selected by Wight (1902) is one collected by W.L. Puto, which is clearly stated in Mendenhall (1902:58)

The locality on the label is given as Old Man Creek, which was the local name given to the Kanuti River during the period 1898-1913 (Orth 1967). In Mendenhall's report, p. 64 the account is "Kanuti River. Collected about 15 miles below Caribou Mountain. July 6," not July 9 as on the label. The map in Mendenhall (1902) gives the major features, a scale, and the dates and places the expedition stopped. They reached a point roughly 15 miles from Caribou Mountain on July 6, and I take that date of collection to be correct.

### 4. Eritrichium chamissonis DC.

*Eritrichium aretioides* var. *chamissonis* (DC.) V.V. Petrovsky
*Eritrichium nanum* var. *chamissonis* (DC.) Herder

Lectotypification of the name *E. chamissonis* and its application have been discussed by Murray (2013). Whereas *E. chamissonis* has been viewed by some as a hybrid between *E. villosum* and *E. aretioides* (Popov 1953) or as merely an ecological modification of *E. aretioides* (Johnston 1924), this species has features that are sufficiently constant to distinguish it from other taxa. Furthermore, it has a distinct geography and does not occur sporadically within the range of *E. aretioides* as would be expected if it were simply an expression of local conditions. The arctic collections of *E. chamissonis* reported by Wiggins and Thomas (1962) and Cody (1996) are compact ecological modifications of *E. aretioides*.

Treatment of *E. chamissonis* at the rank of species (vs being subsumed under *E. aretioides*) rests on different chromosome numbers—2n=24 for *E. aretioides* and 2n=48 for *E. chamissonis*—and the differences in sculpturing of the nutlet epidermis as revealed by preliminary SEM studies (Garroutte et al. 2010). With the exception of St. Lawrence Island, Alaska, the type locality for both species, *E aretioides* and *E. chamissonis* are otherwise allopatric. The best field characteristic lies in whether the flowers just reach the surface of the leaf mass or are on stems exerted beyond it. Variation in leaf shape and indumentum reduce key characteristics to a few.

This couplet may be helpful:

Flowers (3)4–8(10), exerted beyond the mass of basal leaves; leaves oblanceolate, conspicuously pustulate, leaf blades proximally glabrate, distally villous on blades and along margins, marginal hairs to 2 mm, seldom obscuring the terminal leaves, apices acute or obtuse ____ **Eritrichium aretioides**

Flowers 1–2(3), rarely exerted beyond the mass of basal leaves; leaves, broadly oblanceolate to obovate, sparingly pustulate, leaf blades villous, densely so at apices especially along margins, marginal hairs to 3 mm, often obscuring the terminal leaves, apices obtuse to rounded ____ **Eritrichium chamissonis**

### 5. The disposition of *Eritrichium howardii* (A. Gray) Rydb.

*Eritrichium howardii* is a narrow endemic of the Rocky Mountain region (Montana and Wyoming) that is distinct from the common, widespread *E. argenteum* found in the region. By its indumentum, *E. howardii* is allied with *E. sericeum* s.l., therefore its closest relatives in North America are in Alaska and Yukon, but one cannot rule out that it is even more closely related genetically to Asian species.

Given the diversity of species in Asian *Eritrichium* and relatively few species in North America, one could reasonably presume a movement from west to east. Furthermore, when the floras of Chukotka and Alaska are compared, movement from Asia to America is well demonstrated. Since *E. howardii* is so morphologically and ecologically distinct and geographically isolated, it is not likely to have arrived nor arisen recently. It or its antecedents have most likely come from *E. sericeum* s.l. prior to the Quaternary.

Weber (1965, 2003) has sought to explain extraordinary disjunctions of taxa in the mountains of northeastern Asia and northwestern America, postulating a Late Tertiary flora of which *E. howardii* or an antecedent were a part, essentially continuous from Asia to America, but which became dissected and greatly reduced in area by Quaternary events, e.g., the Ice Ages.

There is no direct evidence for these scenarios; they are speculation but well-reasoned. This species, and for that matter the entire genus, is an excellent candidate for a phylogeographic study since molecular genetics might provide answers to questions such as where and when this species arose.

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Gandhi has, as always, been extremely helpful with matters of nomenclature. I thank Svetlana Ovchinnikova (NSK) and Vladik Petrovsky and Volodya Razzhivin (LE) for responding to my many questions about the genus *Eritrichium* in northeastern Asia.

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# BOOK REVIEW

Thor Hanson. 2015. **The Triumph of Seeds: How Grains, Nuts, Kernels, Pulses, & Pips Conquered the Plant Kingdom and Shaped Human History.** (ISBN-13: 978-0-465-05599-9, hbk). Basic Books, 250 West 57th St, New York, New York 10107, U.S.A. (**Orders:** www.basicbooks.com, 1-800-343-4499). $26.99 US, 304 pp., 5.75" × 8.5".

The book we tend to pick up is mostly the book with an eye-catching cover design and an intriguing title. A clear validation of such an axiom is Nicole Caputo's book cover design and Thor Hanson's *The Triumph of Seeds: How Grains, Nuts, Kernels, Pulses, & Pips Conquered the Plant Kingdom and Shaped Human History.*

According to Hanson, the dramatic triumph of seeds poses an obvious question: Why are they so successful? What traits and habits have allowed seeds, and the plants that bear them, to thoroughly transform our planet? The answers frame the narrative of Hanson's work and reveal not only why seeds thrive in nature but also why they are so vital to us. In the table of contents alone, we learn that seeds nourish, seeds unite, seeds endure, seeds defend, and seeds travel.

Hanson delivers botanical information with wit and imagination. The text uses only common names of plants. However, there is a complete list of common and scientific names at the end of the book (Appendix A). In addition, there are extensive notes to each chapter, a glossary, bibliography, and an index. *The Triumph of Seeds* is an excellent addition to the single-issue science genre. It describes how little seeds shaped history in big ways and why the future of seeds is such a hot button issue.

When are you going to plant *The Triumph of Seeds* in your library?—*Kay M. Stansbery, Ph.D., retired librarian and BRIT volunteer, Fort Worth, Texas, U.S.A.*

**Thor Hanson** is a conservation biologist, Guggenheim Fellow, Switzer Environmental Fellow, and winner of the John Burrough Medal for excellence in nature writing and natural history. The author of *Feathers* and *The Impenetrable Forest*, Hanson lives with his wife and son on an island in Washington State.

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# CHANGE IN TAXONOMIC RANK FOR A *HEXASTYLIS* (ARISTOLOCHIACEAE) TAXON OF THE SOUTHEASTERN UNITED STATES

Brian R. Keener
*University of West Alabama (UWAL)*
*Department of Biological & Environmental Sciences*
*Livingston, Alabama 35470, U.S.A.*
*bkeener@uwa.edu*
*and*
*Botanical Research Institute of Texas (BRIT)*
*1700 University Drive, Fort Worth, Texas 76107, U.S.A.*

L.J. Davenport
*Samford University (SAMF)*
*Department of Biological & Environmental Sciences*
*Birmingham, Alabama 35229, U.S.A.*
*ljdavenp@samford.edu*

## ABSTRACT

A taxonomic innovation is proposed: **Hexastylis harperi** (Gaddy) B.R. Keener & L.J. Davenp., comb. et. stat. nov. This new species is distinct in morphology, habitat, and distribution and shows no intergradation with more widespread and typical, putatively conspecific populations.

## RESUMEN

Se propone una innovación taxonómica: **Hexastylis harperi** (Gaddy) B.R. Keener & L.J. Davenp., comb. et. stat. nov. Esta nueva especie es distinta en morfología, hábitat, y distribución y no muestra intergradación con poblaciones más generalizadas y típicas, putativamente conspecíficas.

In preparing for the writing of a taxonomic manual for the flora of Alabama, it will be necessary to make changes in ranks of taxa to address the biodiversity represented. As the *Flora of Alabama* project continues, there will undoubtedly be future papers for additional issues as they arise. This paper is the first such installment.

During June 1927, Roland Harper discovered a plant resembling *Hexastylis shuttleworthii* (Britten & Baker f.) Small in a swamp in central Alabama (Autauga County); in 1935, he found a similar-appearing plant in northwest Alabama's Marion County (Harper 1936). Gaddy (1987a) later described Harper's discovery as a variety of *Hexastylis shuttleworthii* (*H. shuttleworthii* var. *harperi* Gaddy) from the upper Coastal Plain of Alabama and Georgia. Variety *harperi* has long rhizomes, which support leaves along their entire lengths, and grows at bog edges and in acidic hammocks of that Coastal Plain. In contrast, var. *shuttleworthii* has short rhizomes with solely terminal leaves and grows along upland, rocky, forested slopes of the Blue Ridge, Ridge & Valley, and Appalachian Plateau ecoregions (see Gaddy 1987b and Whittemore & Gaddy 1997 for further details).

The two varieties of *Hexastylis shuttleworthii* are distinct in morphology, habitat and distribution. They are completely allopatric, showing none of the geographical gradations associated with the concept of varieties. For these reasons, we maintain that species rank is warranted.

Further evidence supporting this change was recently published in broader evolutionary investigations of *Asarum* s.l. (Sinn et al. 2015a, 2015b). In both studies, and using different analyses, the authors found that the two vars. of *Hexastylis shuttleworthii* (as *Asarum shuttleworthii* Britten & Baker.f) were polyphyletic rather than "sister" to each other, as would be expected.

It is worth noting that some modern workers (Barringer 1993; Kelly 1997, 1998; Sinn et al. 2015a, b) prefer to subsume *Hexastylis* into a broadly circumscribed *Asarum*, but we here follow the generic circumscriptions used in two recent and influential continental and regional floras, the *Flora of North America* (Whittemore & Gaddy 1997) and the *Flora of the Southern and Mid-Atlantic States* (Weakley 2015).

**Hexastylis harperi** (Gaddy) B.R. Keener & L.J. Davenp., comb. et stat. nov. Basionym: *Hexastylis shuttleworthii* (Britten & Baker f.) Small var. *harperi* Gaddy, Sida 12:54. 1987. Type: U.S.A. GEORGIA. Madison Co.: acidic bog under *Acer rubrum*, *Lirioden-*

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*dron tulipifera*, and *Nyssa sylvatica* var. *biflora*; growing on small hammocks with *Osmunda cinnamomea* and along bog edges with *Medeola virginiana* and *Isotria verticillata* just N of GA 106, 14.2 mi NE of Athens, 9 May 1986, *Gaddy s.n.* (HOLOTYPE: CLEMS; ISOTYPES: AUA, GA, GH, MO, NCU, NY, TENN, UNA, VDB).

*Hexastylis speciosa* R.M. Harper (Harper 1924) and *H. harperi* have both been called "Harper's Heartleaf" or "Harper's Ginger." We recommend that "Harper's Heartleaf" or "Harper's Ginger" be used for *H. harperi*, since those common names are direct translations of the scientific name. For *H. speciosa*, "Alabama Ginger" and "Alabama Heartleaf" may be more applicable common names, due to the species' restriction to central Alabama.

## ACKNOWLEDGMENTS

We thank our reviewers, Alan Weakley and Guy Nesom, for their very timely and helpful suggestions.

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# *CALATHEA GALDAMESIANA* (MARANTACEAE), A NEW ENDEMIC PANAMANIAN SPECIES

Helen Kennedy
*UCR Herbarium, Dept. of Botany & Plant Sci.*
*University of California Riverside*
*Riverside, California 92521, U.S.A.*
*ganders@mail.ubc.ca*

Rodolfo Flores
*Smithsonian Tropical Research Institute*
*Avenida Roosevelt, Edificio Tupper 401*
*Balboa, Ancón, Rep. de PANAMÁ*
*floresr@si.edu, rflores1184@hotmail.com*

## ABSTRACT

**Calathea galdamesiana** H. Kenn. & R. Flores, endemic to Panamá, is described as new for inclusion in the Flora Mesoamericana. It occurs in premontane wet forest and is known only from the type locality in Parque Nacional Santa Fe, Veraguas Province. It is characterized by the 5–8 basal leaves per shoot, in which the petiole is absent and the margins of the leaf sheath are spreading and reflexed; and the 1–4 fusiform inflorescences borne on a separate, leafless shoot directly from the rhizome. *Calathea galdamesiana* shares a similar vegetative habit and leaf morphology with *C. panamensis* Standl. but differs in the elliptic vs. obovate to obovate-elliptic leaf blade, the 1–4 inflorescences borne on a separate leafless shoot vs. 1 (rarely 2) borne on the leafy shoot, the red-purple vs. green bracts and chasmogamous vs. cleistogamous flowers. The flower morphology of *C. galdamesiana* is most similar to that of *C. cleistantha* Standl. which also has the inflorescences borne on a separate leafless shoot. *Calathea galdamesiana* differs from *C. cleistantha* by the absence of a petiole and the margins of the leaf sheath spreading to recurved vs. petiole (0–)3.5–15 cm and the margins of leaf sheath clasping, the usually shorter pulvinus (0.5–1 vs. 0.9–2.3 cm), and the fusiform vs. ovoid inflorescence (length to width ratio 3.2–4.5:1 vs. <2.5:1).

## RESUMEN

**Calathea galdamesiana** H. Kenn. & R. Flores, endémica de Panamá, es descrita como nueva para inclusión en Flora Mesoamericana. Esta especie se ecuentra en el bosque húmedo premontano y está conocida de sólo de la localidad del tipo en Parque Nacional Santa Fe de Provincia Veraguas. *Calathea galdamesiana* se caracteriza por tener 5–8 hojas basales por brote y la ausencia de pecíolo y las márgenes de la vaina son extendidos a recurvados; y inflorescencias 1–4, fusiformes, en un brote aparte, sin hojas, que sale directamente del rizoma. *Calathea galdamesiana* tiene hábito similar a *C. panamensis* Standl., pero se distingue por sus láminas foliares elípticas vs obovadas u obovado-elípticas, las inflorescencias 1–4, en un brote aparte, sin hojas vs inflorescencia 1 (raramente 2) en un brote con hojas, las brácteas rojo-púrpureas vs. verdes, y las flores casmogamas vs. cleistogamas. La forma de las flores de *C. galdamesiana* es más similar a *C. cleistantha* Standl., la cual también tiene las inflorescencias en un brote aparte, sin hojas. *Calathea galdamesiana* difiere de *C. cleistantha* Standl., por la ausencia del pecíolo y los márgenes de la vaina extendidos a recurvados vs. pecíolos (0–)3.5–15 cm y los márgenes de la vaina abrazados, y el pulvínulo usualmente más corto (0.5–1 vs. 0.9—2.3 cm), y las inflorescencias fusiformes vs. ovoides (proporción largo por ancho 3.2–4.5:1 vs. <2.5:1).

In preparation for the Flora Mesoamericana treatment, the species of Marantaceae from Panama have been a special focus as with increased collecting several undescribed species have been discovered recently. With considerably more collecting since publication of the Woodson & Schery (1945) treatment for Flora of Panama, listing 23 species, the total has tripled. By 1972, Dressler (1972:184) reported a total of 35 species for Panama. Besides field work, recent herbarium studies at Missouri Botanical Garden and University of Panama have uncovered additional new species. Just since 2011, 11 more species of Marantaceae have been described from Panama. Kennedy (2012:49) had reported a total of 63 species whereas, currently, 69 species are recognized (a 200% increase from the original *Flora of Panama* treatment). Twenty species are recognized as endemic, including the one described herein plus another as yet undescribed taxon.

## TAXONOMIC TREATMENT

**Calathea galdamesiana** H. Kenn. & R. Flores, sp. nov. (**Figs. 1, 2**). Type: PANAMÁ. Veraguas: Parque Nacional Santa Fe, alrededores de la parcela ubicada por CBMAP II/ANAM, Alto de Piedra, Guabal, 900 m, 8°31'39"N, 81°08'58"W (UTM 0483553 E, 0942618 N), 18 May 2015, *R. Flores & N. Guerra 3655* (holotype: PMA; isotypes: SCZ, UCH, UCR).

Haec species quoad partes vegetativas *Calatheae panamensi* Rowlee ex Standl. similis, sed ab ea lamina foliari elliptica (vs. obovata vel obovato-elliptica), inflorescentiis 1 ad 4 (vs. 1 raro 2) surculo aphyllo discreto insidentibus, bracteis rubro-purpureis (vs. viridibus) atque floribus chasmogamis; quoad partes florales *C. cleistanthae* Standl. similis, sed ab ea foliis semper sessilibus, vagina florali marginibus patentibus

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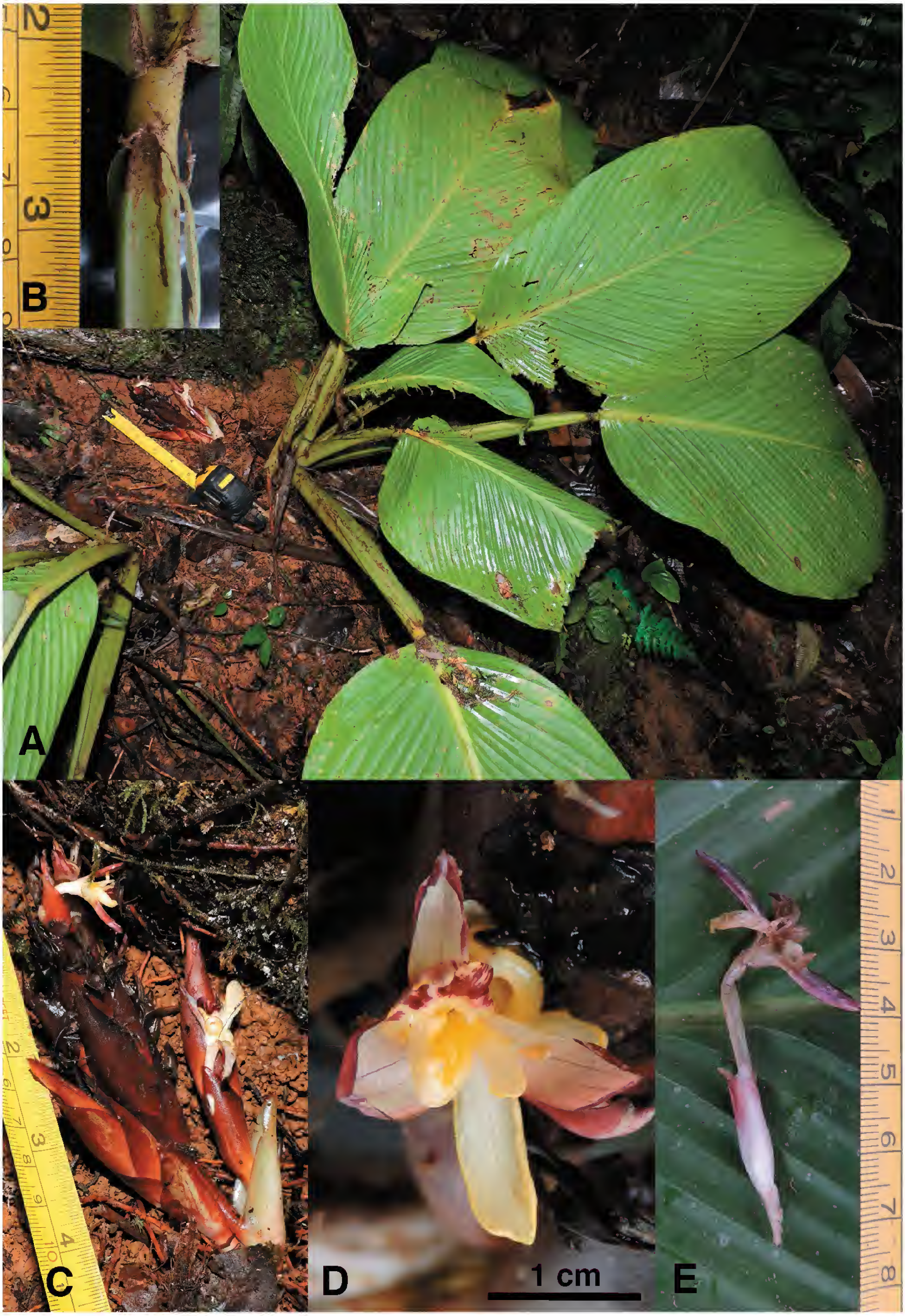
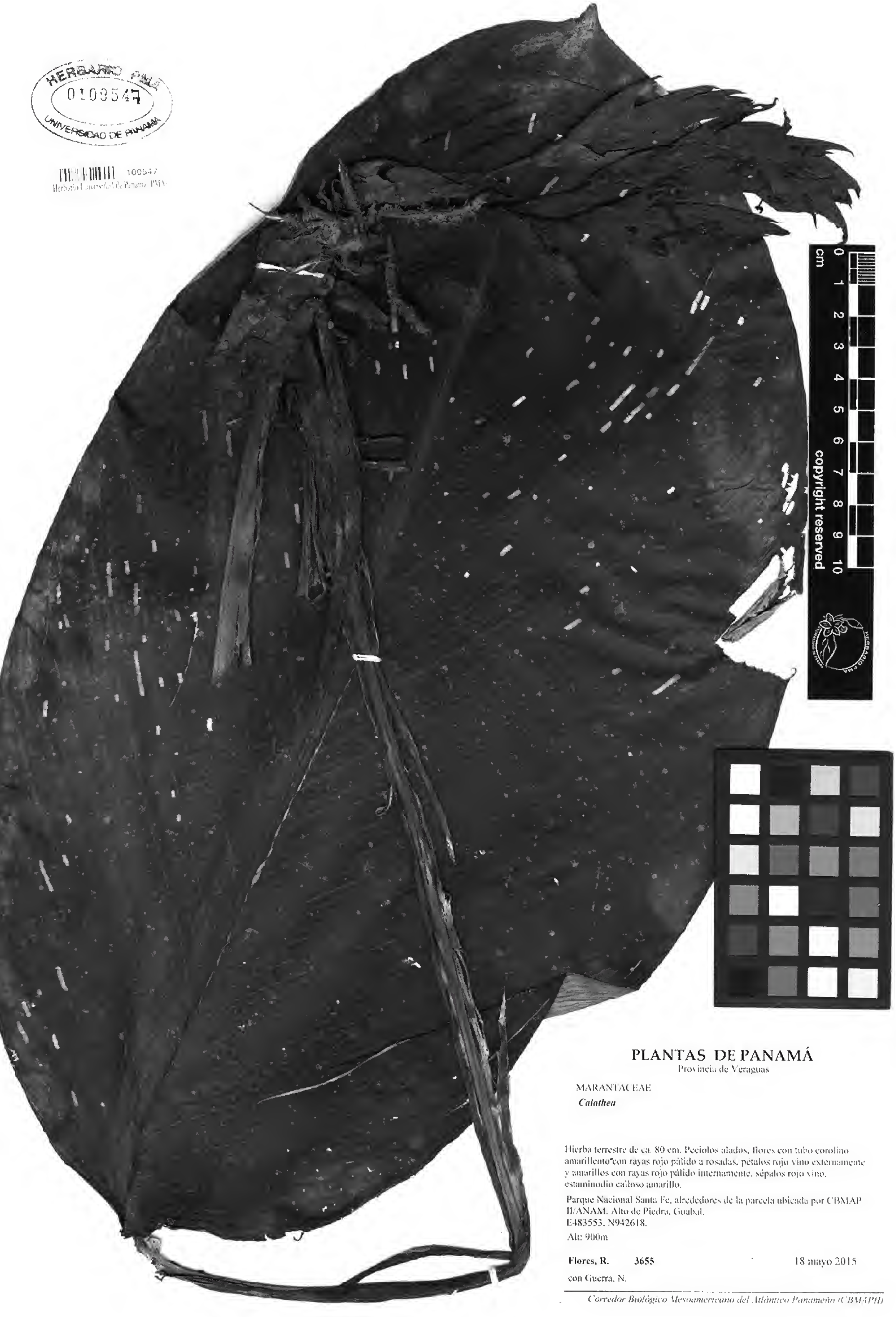


Fig. 1. *Calathea galdamesiana* H. Kenn. & R. Flores. **A.** Habit. **B.** Leaf base, pulvinus and apex of alate leaf sheath. **C.** Inflorescences subtended by cataphyll. **D.** Face view of untripped flower. **E.** Flower on adaxial leaf surface. (*Flores & Guerra 3655*, PMA, photos by Rodolfo Flores).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PLANTAS DE PANAMÁ
Provincia de Veraguas

MARANTACEAE
*Calathea*

Hierba terrestre de ca. 80 cm. Peciolos alados, flores con tubo corolino amarillento con rayas rojo pálido a rosadas, pétalos rojo vino externamente y amarillos con rayas rojo pálido internamente, sépalos rojo vino, estaminodio calloso amarillo.

Parque Nacional Santa Fe, alrededores de la parcela ubicada por CBMAP II/ANAM. Alto de Piedra, Guabal.
E483553, N942618.
Alt: 900m

**Flores, R.** **3655** 18 mayo 2015
con Guerra, N.

*Corredor Biológico Mesoamericano del Atlántico Panameño (CBMAPII)*

Fig. 2. *Calathea galdamesiana* H. Kenn. & R. Flores. Holotype. Type scan provided by PMA (*Flores & Guerra 3655*, PMA).

usque recurvis (vs. amplexicaulibus), pulvino plerumque breviore (0.5–1 vs. 0.9–2.3 cm longo) atque inflorescentia fusiformi (vs. ovoidea) longitudinis cum latitudine proportione 3.2–4.5 (vs. ca. 2.5) distinguitur.

**Plants** rhizomatous, rosulate herbs, 50–80 cm; the inflorescences are borne on a leafless shoot directly from the rhizome; roots bearing swollen "root tubers" 4.3–6.5 × 2–3 cm; cataphylls narrowly ovate, apiculate, green. **Leaves** 5–8 basal; leaf sheath alate, the wings spreading, recurved, the abaxial surface, both wings and central back portion, light green, adaxial portion of wings deep green, central portion of leaf sheath lighter, 18–48 cm; petiole absent; pulvinus light yellow-green to cream-colored, minutely tomentose adaxially, 0.5–1 cm; leaf blade herbaceous, with pleated appearance (tissue between two adjacent veins planar), elliptic, apex obtuse to rounded with acumen, base obtuse to rounded, 23.5–46.2 × 19–25.5 cm (length:width ratios [1.34–]1.81–2.16:1) lateral veins 11 to 14 per 3 cm (measured at midpoint of each side of blade), vein angles from midrib 35°–42°, measured at midpoint of blade, adaxial surface grass-green, midrib yellow-green, noticeably lighter than blade, abaxial surface pale grey-green, midrib cream-colored. **Inflorescences** 1–4 per shoot, the first terminal, subsequent ones in the axil of the subtending cataphyll, imbricate, fusiform, 5.8–10.8 × 1.3–2.5 cm; peduncle red-purple, white if covered by cataphyll, 2.4–6.5 cm, the basal portion, ca. 2 cm, swollen, tissue growth more on one side, causing the inflorescence to be deflexed onto the ground. **Bracts** 6–12, spirally arranged, ovate, apical ones proportionally longer and narrower, apex acuminate, 4–5.9 cm long, abaxial surface of bracts red-purple to brownish purple, darker at margins and apex, becoming very dark, almost blackish purple, in age. **Flowers** open spontaneously. **Sepals** red-purple apically, basal half white, ca. 19 mm long. **Corolla** tube cream-colored to white, ca. 35 mm; corolla lobes subequal, elliptic, apex obtuse, red-purple abaxially, white adaxially with the veins seen as fine purple lines, 17–19 × 5–6 mm. **Staminodes** 3; outer staminode obovate, apex emarginate, yellow, ca. 14–17 × 8 mm; callose staminode totally callose, apex reflexed, obtuse with minute acumen to rounded or somewhat irregular, yellow basally, apical ⅓ dark red-purple, ca. 7 mm wide; cucullate staminode yellow, ca. 10 mm; stamen pale yellow with lateral petaloid appendage 1–3 mm wide; ovary pink, ca. 3mm. **Fruits** and seeds unknown.

Additional specimens: **PANAMÁ. Veraguas:** Parque Nacional Santa Fe, alrededores de la parcela ubicada por CBMAP II/ANAM, cerca a la estación de ANAM, Alta de Piedra, Guabal, E483553 N942618, 3 Sep 2014, *R. Flores, R. Vergara, R. Carranza & J. Aguirre 3654* (MO, PMA).

*Distribution and habitat.—Calathea galdamesiana* is endemic to Panamá. It is known only from the type locality in Parque Nacional Santa Fe, Veraguas Province. It occurs in premontane wet forest habitat. The only collections of it were at 900 m elevation.

*Discussion.—Calathea galdamesiana* belongs to *Calathea* section *Breviscapae* Benth. It is characterized by the 5–8 basal leaves per shoot, the elliptic leaf blades, the absence of a petiole proper, the margins of the leaf sheath are spreading and reflexed, the 1–4 fusiform inflorescences borne on a separate, leafless shoot directly from the rhizome, the petals red-purple abaxially, the outer and cucullate staminodes yellow and callose staminode yellow basally, apical ⅓ red-purple. *Calathea galdamesiana* shares a similar vegetative habit and leaf morphology with *C. panamensis* Standl. but differs in the elliptic vs. obovate to obovate-elliptic leaf blade, the 1–4 inflorescences borne on a separate leafless shoot vs. 1 (rarely 2) borne on the leafy shoot, the red-purple vs. green bracts and chasmogamous vs. cleistogamous flowers. The uncommon leaf morphology, shared with *C. panamensis* (alate, spreading, marginally recurved leaf sheath and lack of petiole) together with the inflorescences borne on a separate, leafless, shoot distinguish *C. galdamesiana* not only from other Panamanian species but from all Central American species and probably South American as well. The Brazilian species, *C. albovaginata* K. Schum., also has an alate leaf sheath, but there, the inflorescence is borne on the leafy shoot. The flower morphology of *C. galdamesiana* is most similar to that of *C. cleistantha* Standl. which also has the inflorescences borne on a separate leafless shoot. *Calathea galdamesiana* differs from *C. cleistantha* by the absence of a petiole and the margins of the leaf sheath spreading to recurved vs. petiole (0–)3.5–15 cm and the margins of leaf sheath clasping, the usually shorter pulvinus (0.5–1 vs. 0.9–2.3 cm), and the fusiform vs. ovoid inflorescence (length to width ratio 3.2–4.5:1 vs. <2.5:1).

The presence of the swollen "root tubers" in *C. galdamesiana* together with the thin textured, plicate leaf, are commonly found in deciduous species such as *C. panamensis*, *C. latifolia* (Willd. ex Link) Klotzsch and *C. macrosepala* K. Schum. Whether this new species is possibly deciduous is not yet known.

*Calathea micans* (L. Mathieu) Körn., *C. microcephala* (Poepp. & Endl.) Körn. and *C. fucata* H. Kenn., in *Calathea* section *Microcephalum* Benth. also exhibit the swollen, and subsequent unequal-sided growth, of the base of the peduncles observed in *C. galdamesiana*. The growth of the base of the peduncle acts to deflex the inflorescence to the ground, usually when in fruit, in the case of *C. micans* and the related species, which are dispersed by ants (Horvitz & Beattie 1980). It is possible this is also the case in *C. galdamesiana* and merits further observation in the field.

*Etymology*.—The specific epithet, *galdamesiana,* is in honor botanist Carmen Galdames, research assistant at SCZ herbarium, Smithsonian Tropical Research Institute, Ancon, Panamá. It is a pleasure to thus recognize her contribution to our knowledge of the Panamanian flora through her collections, photographs, co-authorship of the Catálogo de las Plantas Vasculares de Panamá, her ethnobotanical studies and her generous assistance to the authors in the SCZ herbarium, including sharing her botanical knowledge.

## ACKNOWLEDGMENTS

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# BOOK REVIEW

Sylvan T. Runkel & Dean M. Roosa. 2014. **Wildflowers and Other Plants of Iowa Wetlands. Second Edition.** (ISBN-13: 978-1-60938-285-8, pbk). University of Iowa Press, 119 W. Park Road, 100 Kuhl House, Iowa City, Iowa 52242-1000, U.S.A. (**Orders:** www.uiowapress.org, 1-800-621-2736, uipress@uiowa.edu). $35.00, 373 pp., color photos, 6" × 9".

Though the original nomenclature has not changed, this second edition guide includes updated scientific and common names from *Flora of North America North of Mexico* and *Steyermark's Flora of Missouri* and has all new color photographs. The most noticeable change, however, is to the overall design of the book, including a switch from a landscape 8.75" × 5.75" orientation to a portrait 6" × 9" orientation. This has allowed for the majority of the plant photos to occupy an entire page, a big boost from the first edition that displayed many vertical images at a (now) mere 4.25" × 5.75". Plus the new portrait orientation is simply more practical for a field guide; the increased binding area should translate to greater durability. The page layout is more friendly, with the standard plant metadata now arranged in a sidebar: common names, etymology, family name (including updates), and wetland status according to the 2013 National Wetland Plant List (another new feature). The main text of each species page now contains a cohesive narrative, with a separate "Notes" section at the end for any updated information since the last edition. As a whole, the updates made to this second edition were thoughtful and in hindsight perhaps much-needed. I recommend that all owners of the first edition go ahead and purchase this newest release. You won't be sorry.—*Brooke Best, Ph.D., Botanist and Editor, Botanical Research Institute of Texas, Fort Worth, Texas, U.S.A.*

*From the Publisher*: Originally published in 1999, *Wildflowers and Other Plants of Iowa Wetlands* was the first book to focus on the beauty and diversity of the wetland plants that once covered 1.5 million acres of Iowa. Now this classic of midwestern natural history is back in print with a new format and all-new photographs, just as Iowa's wetlands are getting the respect and attention they deserve.

In clear and accessible prose, authors Sylvan Runkel and Dean Roosa provide common, scientific, and family names; the Latin or Greek meaning of the scientific names; habitat and blooming times; and a complete description. Plants are presented by habitat (terrestrial or aquatic), then refined by habit (e.g., emergent, floating, or submerged) or taxonomic group (e.g., ferns and allies or trees, shrubs, and vines). Particularly interesting is the information on the many ways in which Native Americans and early pioneers used these plants for everything from pain relief to tonics to soup and the ways that wildlife today use them for food and shelter. Each of the more than 150 species accounts is accompanied by a brilliant full-page color photograph by botanist Thomas Rosburg, who has also updated the nomenclature and descriptions for certain species.

After decades of being considered an enemy of the settler, the farmer, and the citizen, Iowa's wetlands have come into their own. We are finally caring for these important habitats. Runkel and Roosa's updated field companion will be a valuable guide to today's preservation and restoration initiatives.

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# *CASEARIA DRAGANAE*, A NEW SPECIES OF SAMYDACEAE FROM WESTERN COLOMBIA AND ECUADOR

Mac H. Alford

*Department of Biological Sciences*
*University of Southern Mississippi*
*Hattiesburg, Mississippi 39402, U.S.A.*
*mac.alford@usm.edu*

## ABSTRACT

A new species of *Casearia* (Samydaceae), **C. draganae** M.H. Alford, from lowland rainforest of the Pacific basin of Colombia and Ecuador is described and illustrated. The new species is vegetatively similar to *Casearia fasciculata* (Ruiz & Pav.) Sleumer but differs in petiole length, distribution of pellucid-punctations in the lamina, flower size, ovary pubescence, and pericarp thickness.

## RESUMEN

Se describe e ilustra una nueva especie de *Casearia* (Samydaceae), **C. draganae** M.H. Alford, del bosque inundable de la vertiente del Pacífica de Colombia y Ecuador. Por sus hojas, la nueva especie es similar a *Casearia fasciculata* (Ruiz & Pav.) Sleumer pero difiere en la longitud del peciolo, la distribución de punteaduras traslúcidas en la lámina, el tamaño de las flores, la pubescencia del ovario y el grosor del pericarpio.

Key Words: *Casearia*, *Casearia* sect. *Casearia* species group 'Singulares,' Colombia, Ecuador, Flacourtiaceae, Salicaceae, Samydaceae

## INTRODUCTION

*Casearia* Jacq. includes about 180–200 species distributed pantropically and is the largest genus of Samydaceae (Alford 2005, 2007), or the second or third largest genus of a broadly circumscribed Salicaceae (Chase et al. 2002; APG 2009). It is a common genus of tropical forests worldwide (cf. Phillips & Miller 2002), but specimens are notoriously difficult to identify to species due to the small size of the flowers, usually <5 mm and occasionally <2 mm long, and the importance of microscopic floral features such as staminodes and anther connectives in the keys of major treatments (e.g., Sleumer 1980). Fruits are rather variable in the genus, but few treatments offer keys that utilize fruit characters (e.g., Olson et al. 1999; Alford 2003; Zmarzty 2007).

Most species of *Casearia* belong to section *Casearia*, which was divided into six informal "species groups" by Sleumer (1980). According to Sleumer (1980), *Casearia* sect. *Casearia* species group 'Singulares' consists of two species, *C. fasciculata* (Ruiz & Pav.) Sleumer and *C. combaymensis* Tulasne, but with additional collections of the last 35 years, especially from Ecuador, Peru, and the Guiana Shield, his treatment is now inadequate. In addition, the type specimen of *C. combaymensis* is in conflict with his description and instead represents a species in *Casearia* sect. *Casearia* species group 'Decandrae' (see Mori & Fischer 2002 for details). Several new species of species group 'Singulares' are being prepared for description, and several additional species with names placed in synonymy by Sleumer (1980) will again be applied in an upcoming revision (M.H. Alford, in prep., see also Mori & Fischer 2002). One of the new species is described here. It is remarkably similar to *C. fasciculata* vegetatively but has shorter petioles, larger flowers, and fruits with thicker pericarps. *Casearia fasciculata*, the type of which is from Chinchao (Huánuco), Peru, is distributed on the eastern slopes of the Andes and in Amazonia; the new species described here is distributed in the lowlands west of the Andes along the Pacific coast in the Chocó biogeographic region.

## TAXONOMIC TREATMENT

**Casearia draganae** M.H. Alford, sp. nov. (**Fig. 1**). Type: COLOMBIA. Valle del Cauca: Bajo Calima; Concesión Pulpapel / Buenaventura, bosque pluvial tropical, 03°55'N, 77°00'W, 100 m, 23 Nov 1984 (fl., fr.), *M. Monsalve B. 541* (holotype: COL).

*Casearia draganae* differs from *Casearia fasciculata* (Ruiz & Pav.) Sleumer in its shorter (1–5.5 mm) petioles, larger flowers (sepals 5.0–5.4 mm long), densely hispid ovary, and fruits with thicker (1.2–3 mm) pericarp.

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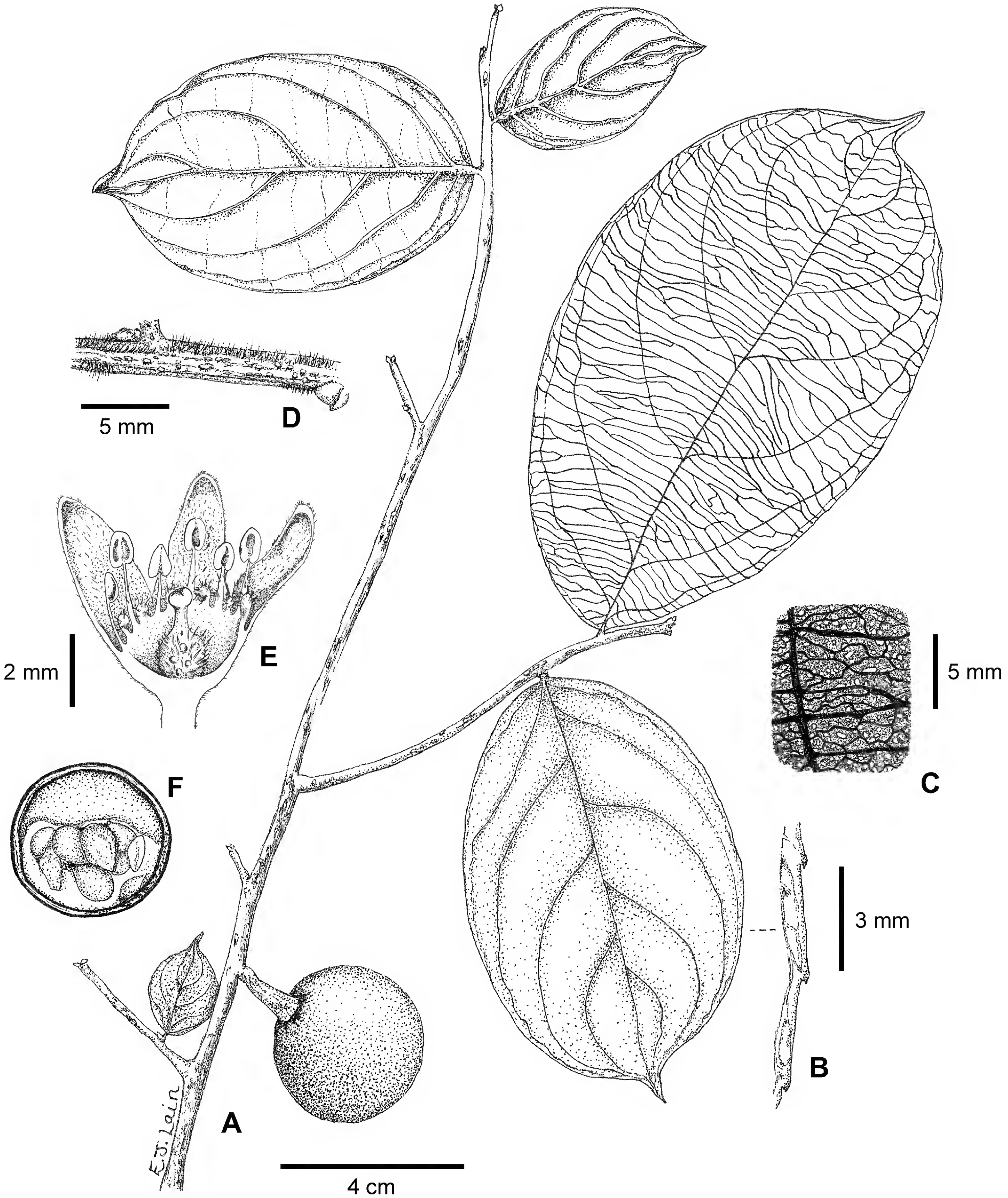

Fig. 1. *Casearia draganae* M.H. Alford. **A.** Fruiting branch, the upper two leaves showing the abaxial surface and highlighting the raised venation, the other leaves showing the adaxial surface, one highlighting the tertiary venation perpendicular to the midvein. **B.** Leaf margin, showing the obscure leaf teeth, each with a small deciduous cap ("theoid teeth"). **C.** Pellucid-punctations and tertiary and finer venation of the lamina, as seen with transmitted light. **D.** Detail of branch between two nodes, highlighting pubescence and lenticels. **E.** Flower, in part, longitudinal section, showing 3 of the 5 sepals and 6 of the 10 stamens. **F.** Cross-section of the fruit, about ½ empty after drying. A–D drawn from *Devia A. & Prado 2386* (MO) and F drawn from *Monsalve B. 510* (MO) by Emily J. Lain. E drawn from *Monsalve B. 541* (COL) by Tharangamala Samarakoon.

**Shrubs to small trees,** 2.5–8 m tall [and probably taller, as many *Casearia* reach reproductive maturity at small height], dbh 2.5–8 cm. Young **stems** angled, often reddish brown to maroon when dry, puberulent, hairs sometimes more dense on one of the stem faces, with numerous elliptical to narrowly elliptical lenticels; older stems gray, glabrescent. **Leaves** alternate, simple, persistent, broadly elliptic to elliptic to obovate, rarely narrowly elliptic, (7.5–) 10–21 cm long, (3–) 4–8 cm wide, apex abruptly acuminate for 0.5–3 cm, base acute to attenuate, infrequently obtuse to rounded, subcoriaceous to coriaceous, light green, slightly darker green above when dry, glabrous, densely pellucid-punctate and -lineate, serrate, sometimes obscurely so, the serrations minute, each with a small, conical, deciduous cap, ca. 3 teeth/cm in the middle third of the lamina, 4–6 pairs of lateral secondary veins curved ascending, weakly raised above, midvein more distinctly raised within a trough in the upper ¾, midvein and secondaries distinctly raised abaxially and contrasting with lamina, tertiary veins ± perpendicular to the midvein; petiole glabrous or with a few scattered hairs near base, 1–5.5 mm long, 0.7–1.8 mm in diameter; stipules narrowly lanceolate, 5.5 × 0.8 mm, margins entire, 3-veined, glabrous, pellucid-punctate, quickly caducous. **Inflorescences** axillary glomerules or fascicles, the glomerules often appearing like 5–6 small balls of bracts, potentially producing >16 flowers in total [only one flowering individual seen; 3 flowers were present], bracts numerous and closely arranged, chartaceous, broadly ovate, ca. 2 mm long, beige to light reddish brown, glabrous, ultimate peduncles [pedicels below the articulation *sensu* Sleumer 1980] short, slightly thicker than pedicel or expanded just below pedicel, articulation pubescent, pedicels [pedicels above the articulation *sensu* Sleumer 1980] 4 mm long, 0.3 mm in diameter, densely pubescent, pubescence golden when dry. **Flower buds** ellipsoidal, ca. 2 × 1.3 mm. **Flowers** perigynous, hypanthium 1.5 mm long, sparsely puberulent outside, mostly glabrous inside, with several vein-like ridges on the outer surface, corresponding to vasculature of stamens; sepals (4–)5, the free lobes lanceolate-oblong, 3.5–3.9 mm long (total length, base to apex including hypanthium, 5.0–5.4 mm), 1.6–2.0 mm wide at base of lobes, each lobe with 3 major veins and several minor ones, densely puberulent on both surfaces, white to greenish-yellow, hairs drying golden; petals lacking; stamens 10, slightly unequal in length, the longer with filaments 2.0 mm and opposite sepals, the shorter 1.3–1.4 mm and alternating with sepals, filaments sparsely to moderately pilose, anthers ellipsoidal, 0.4–0.6 × 0.3–0.5 mm, glabrous, dorsifixed, introrsely dehiscent, yellow, lacking or with a very small apical extension of the connective, staminodes alternating with stamens, oblong to ligulate, 0.6–0.7 × 0.3 mm, densely pilose; pistil 1, ovary superior, ovoid, 1.5 mm tall, 1.3 mm in diameter, hispid and verrucose on outer surface, possibly pellucid-punctate, placentation parietal, style stout, 0.75 × 0.4 mm, stigma capitate, smooth, 0.55 mm in diameter; staminodes and stigma presented at about the same height, just above the rim of the hypanthium. **Fruits** globular, probably a tardily dehiscent capsule, 2.4–4.8 cm diameter, pericarp coriaceous, 1.2–2.5 (–3) mm thick, outer surface densely verrucose, dark green turning yellow to yellow-orange when mature, on a moderately puberulent pedicel, 4 mm thick. **Seeds** 15 or more, flattened-ellipsoidal with pellucid-punctation streaks, 1.4 × 0.8–0.9 × 0.2 cm, each covered by a clear (colorless), slimy, sweet aril.

*Phenology.*—With fruits throughout the year. Flowering specimens are known from late November, early December, and April; flower buds also known from July.

*Distribution and habitat.*—Lowland rainforest of the Pacific coasts of Colombia (Nariño, Valle del Cauca) and Ecuador (Esmeraldas, Los Ríos). Known from primary and secondary forest, where soil is commonly nutrient poor but high in aluminum, 10–350(–1100?) m elevation. Associates include *Attalea*, *Vismia*, *Isertia*, *Cecropia*, *Miconia*, *Ammandra*, *Psychotria*, *Goupia*, *Pourouma*, *Vochysia*, *Mabea*, and *Inga*. A detailed description of one of the areas where the species has been collected many times may be found in Faber-Langendoen & Gentry (1991).

Common Name.—“Caimito” (*van Rooden et al. 386*).

*Etymology.*—Named in honor of my wife, Dragana Mladenović Alford, for enduring and supporting my research endeavors. In the Serbo-Croatian language, Dragana means “sweetheart,” based on the root “drag,” meaning “dear,” “beloved,” or “precious” (Benson 1994). Given that fruits of this species are noted to be sweet, the epithet is appropriate.

*Conservation Status.*—Probably least concern, as the species sometimes inhabits disturbed habitats. However, the Ecuadorian part of its range has very little of its original forest cover (Rodríguiez-Mahecha et al. 2004).

Additional specimens examined: **COLOMBIA. Depto. Nariño:** Municipio Barbacoas, corregimiento Junín, sitio La Guaraperia a 3 km de Junín, vía Junín-Tumaco, 1100 m [?], Mar 1995, *J.L. Fernández et al. 12548* (COL). **Depto. Valle del Cauca:** Río Calima, La Trojita, 5–50 m, 19 Feb–10 Mar 1944, *J. Cuatrecasas 16646* (US); Buenaventura Municipio, region of Bajo Calima, along road between Buenaventura and Malaga, at km 50.5, 04°09'N, 77°11'W, <100 m, 7 Feb 1990, *T.B. Croat & J. Watt 70325* (MO); San Isidro, vía a Malaga, km 51, 30 m, 27 Feb 1990, *W. Devia A. 3019* (MO-2); Buenaventura, Corregimiento Bendiciones, vía a Aguaclara, calima medio, Región Fitogeográfica del Chocó, 120 m, 2 Feb 1989, *W. Devia A. & F. Prado 2386* (MO); Bajo Calima Concession, ca. 15 km NW of Buenaventura, 3.7 km from Juanchaco gate, 1 km past Luchin/Lijal on Luchin, 03°53'N, 77°10'W, 50 m, 17 Jun 1987, *D. Faber-Langendoen 960* (MO-2); Bajo Calima Concession, ca. 20 km N of Buenaventura, ca. 300 m NW of "Dindo III, Dindo IV" intersection on "Dindo IV," 03°59'N, 77°04'W, 50 m, 27 Jun 1988, *D. Faber-Langendoen & J.A. Hurtado 1495* (MO), *1521* (MO); Bajo Calima Concession, ca. 20 km N of Buenaventura, behind Pulpapel Forestry Station, 03°56'N, 77°03'W, 50 m, 6 Jul 1988, *D. Faber-Langendoen & J.A. Hurtado 1620* (MO-2); Bajo Calima Concession, ca. 25 km NW of Buenaventura, ca. 9 km NW of San Isidro intersection on "Canalete," near gate, 03°59'N, 77°08'W, 50 m, 8 Jul 1988, *D. Faber-Langendoen & J.A. Hurtado 1667* (MO), 13 Jul 1988, *D. Faber-Langendoen & J.A. Hurtado 1761* (MO); Bajo Calima Concession, ca. 20 km NW of Buenaventura on San Isidro road, 4 km N of San Isidro-Juanchaco Norte intersection, 03°58'N, 77°07'W, 50 m, 4 Aug 1988, *D. Faber-Langendoen & J.A. Hurtado 1976* (MO), *1978* (MO); Buenaventura Municipio: Bajo Calima Concession ca. 16 km NW of Buenaventura and 1 km from Juanchaco gate on Tomar Rd., 04°01'N, 77°10'W, 50 m, 25 Jun 1987, *D. Faber-Langendoen & E. Renteria 1116* (MO); Bajo Calima Concession, ca. 20 km N of Buenaventura, behind Pulpapel Forestry Station, 03°53'N, 77°00'W, 50 m, *D. Faber-Langendoen & E. Renteria 1311* (MO); Bajo Calima Concession, ca. 16 km N of Buenaventura, behind Pulpapel Forestry Station, 03°40'N, 77°00'W, 50 m, 24 Apr 1987, *D. Faber-Langendoen, E. Renteria, & M. Monsalve 247* (MO); Río Naya, upriver from Puerto Merizalde, 03°15'N, 77°25'W, 10 m, 23 Feb 1983, *A. Gentry & A. Juncosa 40693* (MO); Across from Pulpapel camp, ca. 15 km N of Buenaventura, 03°59'N, 77°05'W, 50 m, 9 Apr 1987, *A. Gentry et al. 56698* (MO); Bajo Calima, ca. 15 km N of Buenaventura, "new" Dindo area, 03°59'N, 77°02'W, 10 Apr 1987, *A. Gentry et al. 56758* (MO); Bajo Calima, Concesión Pulpapel / Buenaventura, 03°55'N, 77°00'W, 100 m, 20 Nov 1984, *M. Monsalve B. 510* (CUVC, MO), 13 Dec 1984, *M. Monsalve B. 619* (COL), 25 Jul 1989, *M. Monsalve B. 3076* (MO); Bajo Calima, Concesión Pulpapel / Buenaventura, carretera gasolina Pt4, 03°55'N, 77°00'W, 100 m, 20 Oct 1987, *M. Monsalve B. 2006* (MO); Municipio Buenaventura, forest exploitation in the concession of Cartón de Colombia, 03°56'N, 77°10'W, 230 m, 15 Nov–6 Dec 1979, *J. van Rooden, B.J.H. ter Welle, & S.M.C. Topper 386* (MO, U). **ECUADOR. Prov. Esmeraldas:** San Miguel, Sector Río Grande, Comunidad Corriente Grande, 00°45'N, 78°47'W, 350 m, 22 Nov 1992, *G. Tipaz et al. 2320* (MO). **Prov. Los Ríos:** Río Palenque Biological Station, km 56 Quevedo-Santo Domingo, 150–220 m, 11 Feb 1973, *C.H. Dodson 5238* (L, US), 2 Oct 1976, *C.H. Dodson & A. Gentry 6455* (L, MO), 8 Oct 1976, *A. Gentry & C.H. Dodson 18036* (MO), 17 Jan 1977, *C.H. Dodson 6623* (L, MO).

In flower, *Casearia draganae* is easily recognized as a member of the 'Singulares' group due to the well-developed hypanthium and the mostly included pistil with a globose or ovoid, rather than ellipsoidal or narrowly ellipsoidal, ovary. Using Sleumer's key (1980: 304), the user will reach an impasse, as the sepal size falls closer to the range of *C. combaymensis* (*sensu* Sleumer), but the disk lobes are hairy as in *C. fasciculata*. Other species, some new and some previously synonymized (e.g., *C. bracteifera* Sagot, *C. singularis* Eichler, *C. subopaca* Triana & Planch., *C. petiolaris* Poepp. ex Eichler) can be distinguished from *C. draganae* in having one of these features: glabrous young branches, leaves with pubescent veins abaxially, entire leaf margins, or long petioles (>1 cm). Species group 'Singulares' can also *sometimes* be recognized by the large pellucid punctations and lines, which are evenly distributed and are included within a single areola of veins (Sleumer 1980). In the case of *C. draganae* and some of the other species, though, this is not always true, as many smaller punctations may exist, too (see Fig. 1C).

In fruit, *Casearia draganae* may be confused with other species of group 'Singulares' but also with other large-fruited species with colorless arils in group 'Decandrae.' Identification in fruit can be difficult when fruits are collected immature or maturity is not known. In species group 'Singulares,' other species differ from *C. draganae* in having one of these features: thinner (<1 mm) or thicker (4–8 mm) fruit walls, longer petioles (8–24 mm), or entire leaf margins. Among the members of species group 'Decandrae,' *Casearia pitumba* usually has smaller fruits (2–3 cm diameter) with a hairy remnant of the style base, *C. cajambrensis* has prominently ribbed fruits, and *C. megacarpa* occurs at higher elevations (1250–2200 m). Other large-fruited species either have smaller mature fruits or longer petioles; most occur in the Amazon basin or in sub-Amazonian Brazil.

Preliminary phylogenetic work based on DNA data indicates that species group 'Singulares' may be nested within the broader 'Decandrae' group (Samarakoon 2015, Samarakoon et al., pers. comm.) and that the large-fruited species with colorless arils may form a monophyletic group. Additional collections of these species, especially where flowering and fruiting specimens can be obtained from the same individuals, will assist in clarifying the taxonomy of this group. *Casearia maynacarpa* Liesner & P. Jørgensen (Jørgensen & Liesner 2013), once placed in *Mayna* Aubl. or *Carpotroche* Endl. (now Achariaceae), may also belong to this group, given its large fruit and thick fruit wall.

## ACKNOWLEDGMENTS

I thank Rodrigo Bernal (COL) for encouraging me to participate in the project to produce the *Catálogo de Plantas y Líquenes de Colombia*, which highlighted a need to study the large-fruited species of *Casearia*, and for sharing information and many images of Colombian herbarium specimens. I thank the curators of A, BH, BRIT, COL, DUKE, F, GB, GH, L, MICH, MO, U, US, and USMS for loaning specimens for study or accommodating my visits, Ron Liesner (MO) and Tharangamala Samarakoon (USMS) for sharing their critical observations of the family, and Fabián Michelangeli (NY), John P. Janovec (BRIT, MOL), C. E. Timothy Paine (LSU, STI), Mercedes S. Foster (US), Pablo Stevenson (ANDES), and Diana C. Acosta Rojas (ANDES) for providing field images of various large-fruited species that helped to highlight important characteristics. I also thank Tharangamala Samarakoon for sharing phylogenetic results on Samydaceae, Emily J. Lain and Tharangamala Samarakoon for preparing the illustrations, Daniel M. McNair (USMS) for assisting in preparation of the manuscript, and David E. Lemke and Nixon Leonardo Cumbicus Torres for helpful reviews.

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# BOOK REVIEW

Paul Dowlearn. 2013. **The Lazy Man's Garden: Maximum return; Minimum input.** (ISBN-13: 978-149106-889, pbk). Self-published, 5314 Southwest Parkway, Wichita Falls, Texas 76310, U.S.A. (**Orders:** www.wvlandscape.com). $14.95, 155 pp., 6" × 9".

Author Paul Dowlearn uses a tongue-in-cheek approach to present sound gardening lore in his newest book *The Lazy Man's Garden: Maximum return; Minimum input*. He shares the wisdom of his own life experiences from observations and experimentation, using a foundation based on organic methods and respecting what Mother Nature provides. He thinks outside the box of synthetic fertilizers and toxic chemicals and follows Nature's plan which he finds "perfectly suited to the Lazy Man." Dowlearn stresses the importance of planning, with an awareness of climate and soil conditions and using plants suitable for the environment. He applies his best insights for successful gardening to achieving common sense solutions. Along with a re-awakening of our role as custodians of the planet, Dowlearn's *The Lazy Man's Garden* touts these as exciting times indeed.—*Pat Gerard, Volunteer, Botanical Research Institute of Texas, U.S.A.*

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# *IRENODENDRON*, A NEW GENUS OF SAMYDACEAE FROM SOUTH AMERICA

Mac H. Alford and Angela D. Dement

*Department of Biological Sciences*
*University of Southern Mississippi*
*Hattiesburg, Mississippi 39402, U.S.A.*
*mac.alford@usm.edu*

## ABSTRACT

**Irenodendron** (Samydaceae), a new genus for three species of shrubs and trees from South America, is described. Previously recognized as members of *Laetia* section *Scypholaetia*, these species (**I. coriaceum**, **I. cupulatum**, and **I. ovalifolium**) differ from *Laetia* sensu stricto in having cupular bracts, an apically divided style, and large rays in the wood. The wood anatomy and style morphology are similar to those of *Ryania* and *Piparea* (=*Casearia* sect. *Piparea*), to which we propose the new genus is closely related.

## RESUMEN

Se describe **Irenodendron** (Samydaceae), un nuevo género para tres especies de arbustos y árboles de Suramérica. Anteriormente reconocidas como especies pertenecientes al género *Laetia* sección *Scypholaetia*, estas especies (**I. coriaceum**, **I. cupulatum**, e **I. ovalifolium**) se diferencian de Laetia sensu stricto en tener brácteas cupulares, estilos divididos apicalmente, y radios largos en la madera. La anatomía de la madera y la morfología del estilo son similares a las de *Ryania* y *Piparea* (=*Casearia* sect. *Piparea*), géneros a los que se propone el estrechamente relacionado *Irenodendron*.

Key Words: Flacourtiaceae, *Irenodendron*, *Laetia* sect. *Scypholaetia*, *Piparea*, *Ryania*, Samydaceae, South America

## INTRODUCTION

Samydaceae (Malpighiales) are a pantropical family of about 256 species of trees and shrubs. They are closely related to Salicaceae, Lacistemataceae, and Passifloraceae (Alford 2005, 2007; Wurdack & Davis 2009; Xi et al. 2012; Samarakoon 2015) and are sometimes included within a broad Salicaceae (Chase et al. 2002; APG 2009). Generic circumscriptions in the family are currently being adjusted, as phylogenetic studies utilizing both morphological and DNA sequence data affirm that the largest genus of the family, *Casearia* Jacq., is polyphyletic (Alford 2005; Samarakoon 2015). One result is that *Casearia* sect. *Piparea* (=*Piparea* Aubl.) (3 spp.) is more closely related to *Ryania* Vahl and *Trichostephanus* Gilg than to other *Casearia*. This relationship is supported by staminode position, style morphology, and wood anatomy (Alford 2005). Unlike most other Samydaceae, the staminodes (or "disk glands" *sensu* Sleumer 1980) in *Ryania*, *Trichostephanus*, and *Piparea* are located *inside* (vs. alternating with) the stamens, the style is apically divided into several branches, each branch with its own stigma (versus not divided), and the wood consists of dark heartwood with large rays, 3–7 mm high, as wide as 15 cells or 240 µm, and visible to the naked eye (versus light-colored heartwood and small rays, mostly <2 mm high and no wider than 7 cells) (Miller 1968, 1975; Hallé & de Wilde 1978).

In preparing a data table for an online interactive key to the species of the family, we noted that three species of *Laetia* L. have a striking morphological similarity to *Ryania* and *Piparea*, including the style and wood characters noted above. Zmarzty (2007), too, noted a "strong, if superficial, resemblance" between one of these species of *Laetia* and one species of *Piparea*, highlighting the similar leaf shape, leaf texture, capsule shape, and capsule indumentum. Indeed, specimens of *Piparea dentata* Aubl. (=*Casearia commersoniana* Cambess.) or *Piparea multiflora* C.F. Gaertn. (=*Casearia javitensis* H.B.K.) could easily be confused with these species vegetatively, in flower, or in fruit; the species of *Piparea*, however, lack the cupular bracts and have a row of staminodes inside the stamens, the staminodes often ligulate and pubescent, contrasting with the thin and glabrous filaments.

Although other species of *Laetia* have been sampled for DNA data, none of these three species has been included (Alford 2005; Samarakoon 2015). Attempts to obtain fresh samples for DNA extraction or to extract

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DNA from herbarium specimens were unsuccessful. These species were placed in *Laetia* sect. *Scypholaetia* by Warburg (1894), and repeated by Gilg (1925), due to the presence of a cup-like bract subtending the flowers, but Sleumer (1980) in his revision of all Neotropical Flacourtiaceae did not recognize the sectional divisions. Given the strong morphological evidence, however, we argue that these species should be recognized as a genus distinct from *Laetia* and hypothesize that it is more closely related to *Ryania* and *Piparea*.

## TAXONOMIC TREATMENT

**Irenodendron** M.H. Alford & Dement, gen. nov. Type: *Irenodendron cupulatum* (Spruce ex Benth.) M.H. Alford & Dement (≡ *Laetia cupulatum* Spruce ex Benth.).

*Laetia* sect. *Scypholaetia* Warb., *Die natürlichen Pflanzenfamilien* III(6a):49. 1894. Type: *Laetia coriacea* Spruce ex Benth., J. Proc. Linn. Soc., Bot 5 (Suppl. 2):84. 1861, hic designatus.

*Irenodendron* is a new genus, similar to *Piparea* Aubl. and *Ryania* Vahl. in its divided style and large rays in the wood. *Irenodendron* differs from those genera in having bracts fused into a cup-like structure subtending the pedicels and in lacking staminodes or "disk glands." *Irenodendron* differs from *Laetia* L. *sensu stricto* in its cup-like bracts, divided style, and large rays in the wood.

Unarmed **shrubs or trees,** to 20 m tall and 30 cm dbh. **Wood anatomy** diffuse porous, pores often solitary, perforation plates simple, intervascular and vessel-ray pitting alternate, both uniseriate homocellular and multiseriate heterocellular rays with long uniseriate extensions present, multiseriate portion of rays >5 cm high and up to 240 µm (15 cells) wide, fiber-tracheids and libriform fibers present, septate, reddish brown deposits abundant in ray cells and fibrous elements (Miller 1975, based on *I. cupulatum*, *Williams 14194* (F), MADw 23726). **Leaves** simple, alternate, distichous, pinnately veined, subcoriaceous to coriaceous, lacking pellucid-punctations or lines (or practically so?), indumentum, if present, simple, margin entire to obscurely serrate, crenate, or sinuate-crenate, petiolate, stipulate, stipules early caducous, lamina drying olive-brown above, brown to reddish-brown below, with black petioles. **Inflorescences** axillary, rarely supra-axillary, fascicles of 3–10 flowers, from foliate or defoliate axils, pedicels surrounded at base by connate bracts forming a cup, the cup sometimes deeply lobed or incised, the cup-like bracts appearing like a calyx and the calyx appearing like a corolla in bud. **Flowers** perigynous, hypanthium <0.5 mm, appearing hypogynous, bisexual, sepals (4–)5(–6), imbricate, connate at the very base, pale green to white to pink, petals absent, stamens 30–74(+) in 2–3 close-set whorls, staminodes or "disk glands" absent, ovary superior, placentation parietal, placentae 3, style branched near apex into 3 branches, each with a minutely capitate stigma. **Fruits** capsules, distinctly 3-sided, valves 3, rusty tomentulose outside, cupular bract persistent. **Seeds** 1–few, arillate.

*Distribution.*—Northern Amazonia, in Brazil, Colombia, Guyana, Peru, and Venezuela, and Pacific coast of Colombia.

*Etymology.*—The name is a compound formed from the Greek words εἰρήνη (=eirene), meaning peace, and δενδρον (=dendron), meaning tree, with hopes of an enduring peace within and among the nations of the Americas.

*Comments.*—Species delimitation in the genus needs further study. Collections that are available are of good quality, but the small number of specimens does not permit a good assessment of variation.

## KEY TO THE SPECIES OF *IRENODENDRON*

1. Leaves lanceolate to lanceolate-oblong to ovate, often sinuate-crenate, apex gradually attenuate to acuminate; pedicels 3–4 mm long, barely surpassing the cup of bracts ____ **I. coriaceum**
1. Leaves ovate, broadly ovate, elliptic, broadly elliptic, or oblong, often entire or obscurely toothed, apex acute or abruptly acuminate for 1 (–2) cm; pedicels 7–10 mm long, distinctly surpassing the cup of bracts
  2. Young branches and petioles pubescent; cup of bracts not conspicuously lobed or incised (although commonly torn along one suture in dried specimens) ____ **I. cupulatum**
  2. Young branches and petioles glabrous or glabrescent; cup of bracts deeply 2–3-lobed ____ **I. ovalifolium**

**Irenodendron cupulatum** (Spruce ex Benth.) M.H. Alford & Dement, comb. nov. Basionym: *Laetia cupulata* Spruce ex Benth., J. Proc. Linn. Soc., Bot. 5 (Suppl. 2):84. 1861; *Guidonia cupulata* (Spruce ex Benth.) O. Kuntze, Rev. Gen. Pl. 1:44. 1891. Type: VENEZUELA. Terr. Fed. Amazonas: ad. flum. Casiquiare supra Vasivae ostium, Dec 1853, *Spruce 3200* (holotype: K (http://apps.kew.org/herbcat/getImage.do?imageBarcode=K000471393), isotypes: L [fragment ex W], P, S, W).

*Distribution.*—Amazonian Brazil, Colombia, Guyana, and Venezuela, possibly Peru; mixed evergreen forest, terra firme, often along streams.

Representative specimens examined: **BRAZIL. Amazonas:** Alto Rio Solimões, municipio de São Paulo de Olivença platô ao sul da cidade, estrada para a localidade do Bom Fim, 25 Nov 1986, *C.A. Cid et al. 8546* (INPA, MG).

**Irenodendron coriaceum** (Spruce ex Benth.) M.H. Alford & Dement, comb. nov. Basionym: *Laetia coriacea* Spruce ex Benth., J. Proc. Linn. Soc., Bot. 5 (Suppl. 2):84. 1861; *Guidonia coriacea* (Spruce ex Benth.) O. Kuntze, Rev. Gen. Pl. 1:44. 1891. Type: COLOMBIA. Guainía: Tomo, Aug 1854, *Spruce 2730* (lectotype, as designated by Sleumer [1980: 251]: K (http://apps.kew.org/herbcat/getImage.do?imageBarcode=K000471398), isolectotypes: B, BR, GOET, P).

*Distribution.*—Amazonian Brazil, Colombia, and Venezuela; savannah or caatinga on white sand.

Representative specimens examined: **BRAZIL. Amazonas:** Rio Negro, Communidade Aparecida, opposite mouth of Igarapé Tuarí, near abandoned portion of Perimentral Norte, 00°20'N, 67°18'W, 6 Nov 1987, *P.J.M. Maas et al. 6932* (F, MG); Savanna, 3 km S of Central Massif of Serra Aracá, 00°49'N, 65°17'W, 100 m, 18 Jul 1985, *G.T. Prance et al. 29677* (MICH); 3 km ao Sul da parte central da Serra Aracá E 8 km a Leste do rio Jauari, 00°49'N, 63°19'W, 60 m, 14 Mar 1984, *W.A. Rodrigues et al. 10523* (MICH). Río Atabapo, Yavita-Pimichin trail near Yavita, 125–140 m, 10 Jun 1959, *J.J. Wurdack & L.S. Adderley 42900* (MICH).

**Irenodendron ovalifolium** (Macbride) M.H. Alford & Dement, comb. nov. Basionym: *Laetia ovalifolia* Macbride, Candollea 5:389. 1934. Type: PERU. Loreto: Mishuyacu near Iquitos, Jan 1930, *Klug 757* (holotype: F (http://emuweb.fieldmuseum.org/web/pages/common/ imagedisplay.php?irn=56562&reftable=efmnh&refirn=257000), isotypes: NY, US).

*Distribution.*—Amazonian Brazil and Peru, and Pacific of Colombia, collection from Colombia possibly a new species; lowland forest on white sand.

Representative specimens examined: **BRAZIL. Rondônia [Mato Grosso of 1931]:** near Tabajara, upper Machado [Ji-Paraná] River region, Nov–Dec 1931, *B.A. Krukoff 1393* (MICH). **PERU. Loreto:** Maynas, Río Nanay, Caseria Mishana, 30 km SW of Iquitos, Callicebus Biological Reserve, 4 km S of Mishana, 13 Aug 1980, *R.B. Foster 4428* (F); Maynas, Yanamono, Explorama Tourist Camp, halfway between Indiana and mouth of Río Napo, 03°28'S, 72°50'W, 130 m, 27 Jun 1983, *A. Gentry et al. 42229* (MO).

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# NEW SPECIES OF *SENEGALIA* (FABACEAE) FROM SOUTH AMERICA

David S. Seigler*
*Department of Plant Biology*
*University of Illinois*
*Urbana, Illinois 61801, U.S.A.*
*seigler@life.illinois.edu*
**corresponding author*

John E. Ebinger
*Emeritus Professor of Botany*
*Eastern Illinois University*
*Charleston, Illinois 61920, U.S.A.*
*jeebinger@eiu.edu*

## ABSTRACT

**Senegalia duartei** Seigler & Ebinger from the state of Rio de Janeiro, Brazil; **S. noblickii** Seigler & Ebinger, from the states of Bahia, Espirito Santo and Pernambuco, Brazil; and **S. phillippei** Seigler & Ebinger from northern South America in Brazil (Amapá and Pará), French Guiana, Guyana, Surinam, and Venezuela (Anzoátegui and Bolívar) are described, illustrated, and compared to their probable nearest relatives.

Key Words: Fabaceae, IUCN Red List, Mimosoideae, *Senegalia*

## RESUMEN

**Senegalia duartei** Seigler & Ebinger del estado de Rio de Janeiro, Brasil; **S. noblickii** Seigler & Ebinger, de los estados de Bahía, Espirito Santo y Pernambuco, Brasill, and **S. phillippei** Seigler & Ebinger localizada desde el norte de América del Sur desde los estados de Amapá y Pará, Brasil, Guayana Francesa, Guyana, Surinam, y Venezuela desde los estados Anzoátegui y Bolívar, son descritas, ilustradas y comparadas con sus especies afines.

The genus *Senegalia* currently comprises approximately 102 taxa in the Neotropics (Barros & Morim 2014), about 68 in Africa, 45 in Asia, and two in Australia (Maslin et al. 2003a, b; Maslin 2015); of which 8 species occur in two or more areas. Both Old and New World members of the genus are shrubs, trees, or lianas, with extrafloral petiolar nectaries, and branches and branchlets usually armed with prickles and lacking stipular spines. The prickles are randomly scattered along the twigs, and also commonly the leaf petiole and rachis though some species have the prickles in lines along the twigs, and prickles are sometimes fused together into lines. In a few species prickles are grouped into twos or threes, usually at or near the nodes. Leaves are bipinnately compound with one to nearly 50 pinna pairs that contain one to many pairs of leaflets. The petiole and rachis have variously shaped glands, the position, structure, and shape being consistent within a species and are of diagnostic importance. Flowers are small, mostly 5-merous, synsepalous, sympetalous, with numerous stamens (usually 50 to 180), the filaments are not fused and are attached to a more-or-less tubular or circular nectary disc located at the receptacle of the flowers just below the usually stipitate ovary. Inflorescences are globose heads or spikes occurring solitary in small clusters in the leaf axils, or grouped into complex axillary or terminal pseudo-racemes or pseudo-panicles. Pods are usually oblong or broadly linear, with 6–15 uniseriate seed, separating into two valves at maturity or rarely indehiscent or separating into indehiscent one-seeded loments.

Until recently the genus *Senegalia* was treated as part of *Acacia* s.l. (Lewis et al. 2005), but recent morphological, chemical and molecular evidence has determined that this large genus represents a polyphyletic unit. In addition, those studies have helped determine relationships within the genus *Acacia* s.l., as well as the position of the genera within the Mimosoideae (Maslin et al. 2003a; Miller & Bayer 2003; Luckow et al. 2003; Miller et al. 2003; Rico-Arce & Bachman 2006; Seiger et al. 2006a; Bouchenak-Khelladi et al. 2010; Gómez-Acevedo et al. 2010; Murphy et al. 2010; Miller & Seigler 2012; Kyalangalilwa et al. 2013). Based on these data, *Acacia* s.l. currently is recognizable as five monophyletic lineages: *Acacia* s.s., *Acaciella* Britton & Rose, *Mariosousa* Seigler & Ebinger, *Senegalia* Raf., and *Vachellia* Wight & Arnott (see Miller & Seigler 2012 for an overview of the new generic classification).

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During the course of our work on the genus *Senegalia* of the New World three undescribed species were noted from herbarium materials. These taxa are clearly distinct and are here proposed as new species.

**Senegalia duartei** Seigler & Ebinger, sp. nov. (**Fig. 1**). Type: BRAZIL. Rio de Janeiro: Arraial do Cabo, Cabo Frio, Oct 1961, *A.P. Duarte, Dárdano & Edmundo 5764* (holotype: F; isotype: MO).

*Senegalia duartei* differs from the morphologically most similar species *S. bahiensis* (Benth.) Seigler & Ebinger in that the leaves are 90–210 mm long (vs. 40–85), the rachis is 70–170 mm long (vs. 20–70), there are 12–26 leaflets/pinna (vs. 6–14), the globose inflorescence is 14–19 mm in diameter (vs. 20–25), the corolla is 2.6–3.6 mm (vs. 3.9–5.2) and the stamens are 6.6–9 mm (vs. 9.5–11.5).

**Liana** to 4 m tall; bark not seen; twigs light to dark purplish brown, slightly flexuous, terete to ridged, glabrous to lightly puberulent; short shoots absent; prickles, light to dark purplish brown, sometimes darker above, flattened, straight to recurved, woody, 1–4 mm long × 1–4 mm wide at the base, glabrous, persistent, widely scattered along the twig, petiole and rachis. **Leaves** alternate, 90–210 mm long; stipules brown, ovate and auriculate, symmetrical, flattened, straight, herbaceous, 10–25 × 10–20 mm at the widest point, glabrous, early deciduous; petiole adaxially grooved, 11–35 mm long, glabrous; petiolar gland usually present, located medially to just below the lowest pinna pair, columnar, 0.7–2.5 mm long, apex 0.4–0.9 mm across, oval, glabrous; rachis adaxially grooved, 70–170 mm long, glabrous, a sessile globose to columnar gland 0.2–0.5 mm long, sometimes present between the terminal pinna pair, apex, flattened, glabrous; pinnae 3 to 11 pairs/leaf, 40–115 mm long, 15–25 mm between pinna pairs; paraphyllidia 0.5–1.1 mm long, early deciduous; petiolule 4.0–6.7 mm long; leaflets 12 to 26 pairs/pinna, opposite, 2.7–4.0 mm between leaflets pairs, oblong, 8–15 × 2.5–4.0 mm, glabrous, lateral veins obvious, 3 to 6 veins from the base, base oblique, truncate on one side, margins not ciliate, apex acute, midvein subcentral to submarginal. **Inflorescence** a densely 25- to 60-flowered globose head 14–20 mm across, in axillary to terminal pseudo-racemose or pseudo-paniculate clusters, the main axis to 300 mm long; peduncles 10–27 mm long × 0.4–0.7 mm thick, pubescent; receptacle usually slightly enlarged, ellipsoidal; involucre 1 (rarely 2) small bracts scattered along the peduncle, early deciduous; floral bracts spatulate, 0.5–1.4 mm long, puberulent, early deciduous. **Flowers** pedicellate, stalk 0.5–1.1 mm long, white; calyx 5-lobed, 1.8–2.6 mm long, lightly pubescent; corolla 5-lobed, 2.6–3.6 mm long, glabrous to lightly puberulent, lobes one-sixth the length of the corolla; stamens 50 to 70, filaments 6–9 mm long, distinct; anther glands absent; ovary pubescent, stipe to 1.1 mm long. **Legumes** straight, flattened, not constricted between the seeds, oblong, 100–170 × 18–23 mm, chartaceous, transversely striated, glabrous, eglandular, dehiscent along both sutures; stipe 16–19 mm long; apex acute, beak 0.6–1.1 mm long. **Seeds** not seen.

*Notes.*—*Senegalia duartei* has large ovate stipules (10–25 mm long, 10–20 mm wide) similar to five other *Senegalia* species from Brazil, *S. bahiensis* (Benth.) Seigler & Ebinger (6–15, 4–10), *S. globosa* (A. Bocage & Miotto) de Queiroz (4–7, 0.8–1.3), *S. grandistipula* (Benth.) Seigler & Ebinger (15–35, 8–25), *S. lasiophylla* (Benth.) Seigler & Ebinger (5–10, 3–6) and *S. tamarindifolia* (L.) Britton & Rose (6–25, 5–20). Although the sizes and shapes of the stipules overlap to some extent, *S. duartei* can be distinguished from each of the other broad-stipule species by other features. *S. duartei* differs from *S. globosa* because the latter has globose petiole and rachis nectaries whereas the glands of *S. duartei* are columnar. In addition, the leaves of *S. duartei* are longer than those of *S. globosa* (40–100 mm) and the globose inflorescence is smaller (14–20 vs 20–29 mm). *S. duartei* differs from *S. grandistipula* because the latter has a spicate inflorescence (20–35 × 20–26) mm. In addition, the corolla and stamens are longer (6–9 and 9.5–11.5 mm, respectively). *S. duartei* can be separated from *S. lasiophylla* by the smaller stipules (5–10 × 3–6), shorter distance between pinnae (5–11 mm), larger globose inflorescence diameter, and calyx, corolla, and stamen lengths (2.8–4.1, 3.9–5.2, and 9.5–11.5, respectively). The anthers of *S. lasiophylla* possess anther glands which do not occur in S. duartei. *Senegalia duartei* can be distinguished from *S. tamarindifolia* by the number of leaflets/per pinna (9–19 × 12–26), a smaller globose inflorescence (20–25 mm), and correspondingly longer calyx, corolla and stamen lengths.

*Distribution and ecology.*—Dry seasonal forests and caatinga, below 500 m in the state of Rio de Janeiro, Brazil.

*Phenology.*—Flowering Sep–Dec.

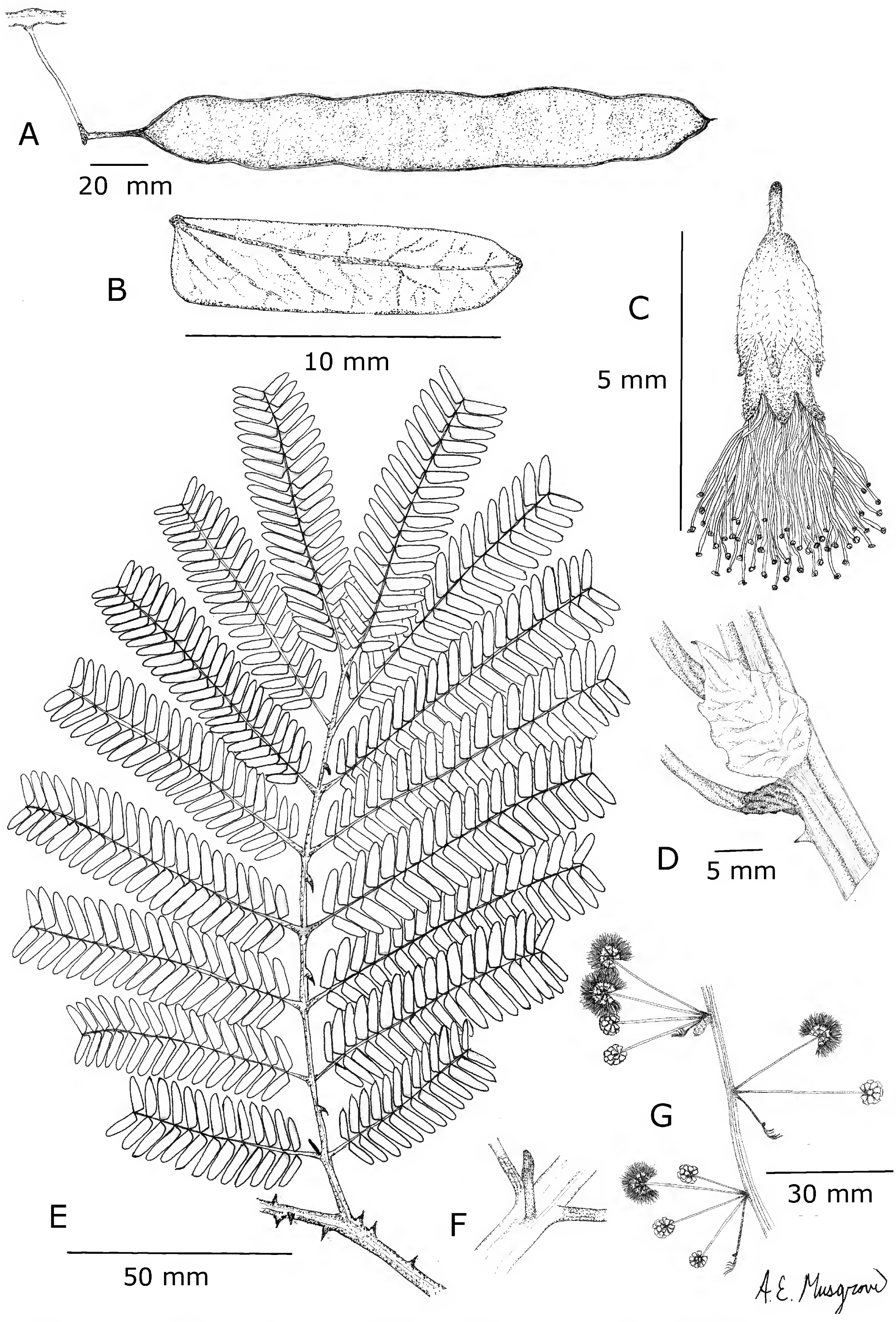

A
20 mm
B
10 mm
C
5 mm
D
5 mm
G
30 mm
E
50 mm
F
A.E. Musgrave

Fig. 1. *Senegalia duartei*. **A.** Legume; **B.** Lower side of leaflet; **C.** Flower (inverted); **D.** Stipule; **E.** Lower leaf surface and stem; **F.** Petiolar gland; **G.** Inflorescences (portion of pseudopanicle). (**A, B, C, G** *L. Riedel 150*, NY; **D** *A.P. Duartei & G.M. Barroso 5040*, FY; **E, F** *L. Riedel 9*, NY).

*Local names and uses.*—None known.

*Etymology.*—This species is named after A.P. Duarte of the Jardin Botánico de Rio de Janeiro who collected extensively in the area of Rio de Janeiro.

*IUCN Red List category.*—DD, data deficient. A rare endemic restricted to the state of Rio de Janeiro, Brazil. We have seen only 12 specimens including the types and have not found any recent collections of this taxon, the last being collected in 1961 (IUCN 2001).

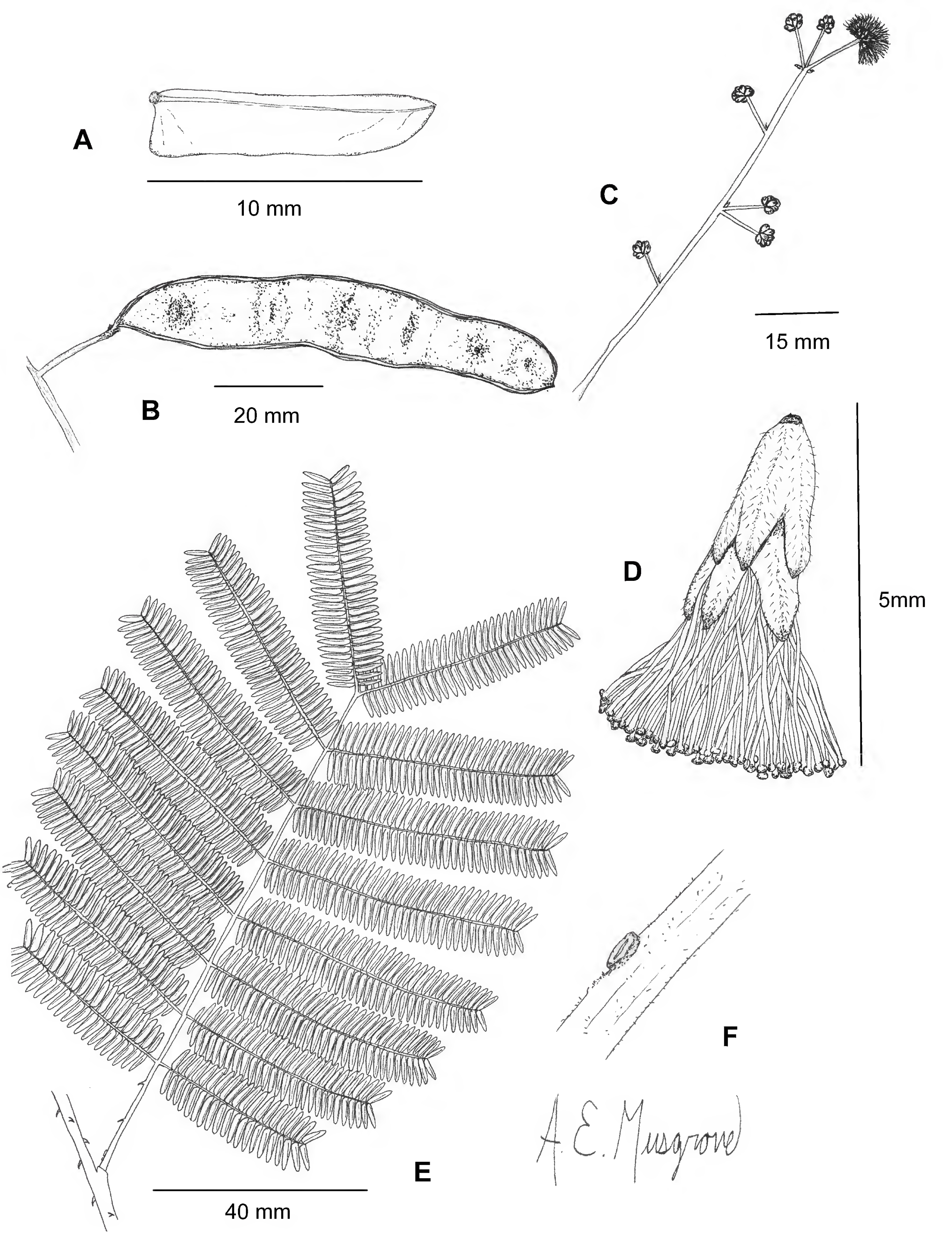
**Paratypes: BRAZIL: Rio de Janeiro:** Rio de Janeiro, 1851, *N.Y. Andersson s.n.* (S); Guanabara, Barra da Tijuca, 30 Sep 1959, *A.P. Duarte 5040* (F); Guanabara, Sacopa, 6 Sep 1960, *A.P. Duarte 5277* (F, MO); Morro da Babilonia, Oct 1914, *F.C. Hoehne s.n.* (HUEFS); Rio de Janeiro, Sep 1829, *L. Riedel 9* (NY); Rio de Janeiro, Dec 1831, *L. Riedel & B. Luschnatt 150* (A, NY, US). **No state listed:** *Glaziou 8438* (F).

**Senegalia noblickii** Seigler & Ebinger, sp. nov. (**Fig. 2**). Type: BRAZIL. Bahia: Iaçú, Faz. Suíbra, 12°43'S/40°7'W, 14 Mar 1985, *L.R. Noblick 3699* (holotype: HUEFS; isotype: NY).

*Senegalia noblickii* differs from it's probable nearest relative *S. tenuifolia* (L.) Britton & Rose which has an orbicular petiolar gland (1.5–4.2 mm long), 10–25 pinna pairs/leaf, leaflets 2.5–5.2 mm long, and 0.5–1.0 mm wide, globose inflorescences 5–10 mm in diameter, and a transversely striated legume.

**Liana** to 10 m long; bark not seen; twigs light brown to light purplish brown, not flexuous, terete to slightly ridged, puberulent; short shoots absent; prickles light purplish brown, the apex usually darker, flattened, recurved, woody, 1–3 × 1–3 mm at the base, glabrous to puberulent, persistent, randomly scattered along the twig, petiole and rachis. **Leaves** alternate, 40–150 mm long; stipules green, triangular, symmetrical, flattened, straight, herbaceous, 1–4 long, 0.7–1.5 mm wide at the base, glabrous, deciduous to persistent; petiole shallowly adaxially grooved, 15–27 mm long, glabrous to lightly puberulent; petiolar gland solitary, located on the lower third of the petiole, sessile, mostly oval, 0.4–1.1 mm long, apex flat, sometimes becoming cup-shaped when mature, glabrous; rachis adaxially grooved, 30–130 mm long, lightly puberulent, an orbicular gland 0.3–0.6 mm across usually between the upper pinna pair, apex depressed and glabrous; pinnae 3 to 13 pairs/leaf, 24–85 mm long, 6–14 mm between pinna pairs; paraphyllidia 0.4–0.9 mm long, commonly absent; petiolule 1.2–2.2 mm long; leaflets 18 to 44 pairs/pinna, opposite, 1.2–2.3 mm between leaflet pairs, oblong, 5.6–11.0 × 1.3–2.5 mm, glabrous or nearly so on both surfaces, lateral veins obvious, 1 to 4 veins from the base, base oblique, truncate on one side, margins lightly ciliate, apex broadly acute to obtuse, midvein nearly marginal at the base, becoming subcentral at the leaflet apex. **Inflorescence** a densely 15- to 35-flowered globose head 9–14 mm across, in terminal pseudo-paniculate clusters, the main axis to 300 mm long; peduncles 2–8 mm long × 0.4–0.6 mm thick, puberulent; receptacle not enlarged; involucre absent; floral bracts spatulate, 0.3–0.6 mm long, puberulent, early deciduous. **Flowers** sessile, white; calyx 5-lobed, 0.8–1.7 mm long, puberulent; corolla 5-lobed, 1.6–2.5 mm long, glabrous to lightly puberulent, lobes one-third the length of the corolla; stamen filaments 4–6 mm long, distinct; anther glands present; ovary pubescent, stipe to 1.6 mm long. **Legumes** straight, flattened, not constricted between the seeds, oblong, 55–120 × 14–23 mm, chartaceous, transversely striated, puberulent, numerous minute purple glands present, dehiscent along both sutures; stipe 2–5 mm long; apex acute to obtuse, short beaked. **Seeds** uniseriate, no pulp, dark brown, orbicular, strongly flattened, 6.5–8.5 × 4.2–5.8 mm across, smooth; pleurogram U-shaped, 1.8–2.4 mm across.

*Notes.*—*Senegalia noblickii* shares many features with *S. tenuifolia*. The relatively small globose inflorescence with small and relatively few flowers suggest a relationship, as does the liana habit, the scattered recurved prickles, the orbicular petiolar gland with a flat apex, and the marginal midvein on the lower part of the leaflet that becomes submarginal above. Of the species similar morphologically to *S. tenuifolia*, *S. noblickii* is most similar morphologically to *S. maschalocephala* (Griseb.) Britton & Rose (endemic to Cuba) and *S. ebingeri* Seigler (endemic to southeastern Peru) by consistently having < 44–45 leaflets/pinna, but can be distinguished from the last two species by the larger inflorescence size (*S. maschalocephala* 12–18 mm, *S. ebingeri* 13–20 mm) and the fact that those two species lack anther glands. Although somewhat similar in morphology to *S. catharinensis* and *S. riparia*, they differ in that they lack anther glands, the leaflets have central venation, and both have two glands on the petiole.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A. E. Musgrove

Fig. 2. *Senegalia noblickii*. **A.** Lower side of leaflet; **B.** Legume; **C.** Inflorescences (portion of pseudopanicle); **D.** Flower (inverted): **E.** Leaf and stem; **F.** Petiolar gland. (**A, E, F** *L.R. Noblick 3699*, HUEFS; **B** *L.P. de Queiroz, C. Correia, J. Costa, & J.G. Nascimento 7304*, HUEFS; **C** *L.R. Noblick 4121*, NY).

*Distribution and ecology.*—Wet tropical forests in alluvial soil, disturbed second growth forest, and caatinga from sea level to 500 m in the states of Bahia, Pernambuco and Espirito Santo, Brazil.

*Phenology.*—Flowering Mar–Jul.

Common name.—None known.

*Etymology.*—This species is named after L.R. Noblick of the Montgomery Botanical Center, Miami, Florida, who collected the type specimen. Mr. Noblick is a notable botanist. He has collected extensively in northeastern Brazil and is a recognized authority on palms.

*IUCN Red List category.*—DD, data deficient. Relatively rare, recently described from about 10 specimens from eastern Brazil (IUCN 2001).

Paratypes: **BRAZIL: Bahia:** Povoado Bizamum, 23 k de Tucano, 10°53'37"S/38°58'21"W, 5 Jun 2004, *D. Cardoso 80* (HUEFS); Feira de Santana, Ipuaçu, 12°13'54"S/39°4'35"W, 200–300 m, 14 Oct 2004, *S.F. Conceição, M.F. Borba-Silva, P.R. Almeida, F. França & R. Castro 2* (HUEFS, NY); Monte Santo, 10°26'19"S/39°20'9"W, 480 m, 27 Feb 2000, *A.M. Giulietti & R.M. Harley 1839* (HUEFS); Riachão de Jacuípe-Rio Toco, 14 km SE da cidade na Br. 324, 12°15'S/38°58'W, 10 Jul 1985, *L.R. Noblick 4121* (HUEFS, NY); Mairí, Margem direita do Rio Jacuípe, 29 Mar 1983, *E.L.P.G. de Oliveira 656* (HUEFS, MO, NY); 1 km E of Sastro Alves, 12°46'21"S/39°19'43"W, 12 Mar 1993, *L.P. de Queiroz, M.J.S.L. Castro & T.S.N. Sena 3079* (NY); Itiuba, Serre de Itiuba, 10°40'55"S/39°48'46"W, 445 m, 16 Aug 2002, *L.P. de Queiroz, C. Correia, J. Costa & J.G. Nascimento 7304* (HUEFS); Maracás, 10 km na estrada para Contendas do Sincorá, 26 Feb 2000, *M.M. da Silva, R.P. Oliveira, I. Castro, & M.A.S. Santos 297* (HUEFS). **Espirito Santo:** Eneruzilhada, margem do Rio Pardo, Matacipó, 26 May 1968, *R.P. Belem 3659* (CM). **Pernambuco:** Floresta, Inajá, Reserva Biológica de Serra Negra, 8 Mar 1995, *G.M. Souza, M. Oliveira, A.P.S. Gomes & A. Laurénio 61* (MO, NY, US). **State not known:** Brasilia, *Blanchet s.n.* (BM).

**Senegalia phillippei** Seigler & Ebinger, sp. nov. (**Fig. 3**). Type: FRENCH GUIANA: liana in disturbed open wooded area, Saül, just E of junction La Fontaine and route de Belizon, 2 km S Les Eaux-Claires, 4.70166°N/52.4223° W, 280 m, 26 Sep 1995, *L.R. Phillippe, J.L. Crane, S. Mori, C. Gracie, B. Wever & R. Yahr 27006A* (holotype: ILLS; isotype: NY).

*Senegalia phillippei* differs from *S. hoehnei* Seigler, M.P. Morim, M.J.F. Barros, & Ebinger which has the petiole, rachis, and young twigs pubescent with curled yellow hairs to 0.5 mm long, the globose inflorescence 12–17 mm in diameter, and the ovary glabrous with a stipe up to 1.1 mm long. *Senegalia phillippei* differs from another similar species *S. martiusiana* which has a petiole pubescent with reddish-brown hairs, a densely pubescent calyx, a glabrous ovary, pedicellate flowers (0.9–1.5 mm long) and leaflets 3.5–6.1 in length.

**Liana** to 35 m tall; bark not seen; twigs dark purplish brown, not flexuous, terete to slightly ridged, usually densely puberulent; short shoots absent; prickles light brown throughout to dark brown toward the apex, flattened, mostly recurved, woody, 1–4 mm long, 1–3 mm wide at the base, usually pubescent near base and sometimes throughout, persistent, scattered along the twig ridges, petiole, and rachis. **Leaves** alternate, 90–180 mm long; stipules dark brown to dark reddish brown, narrow triangular, symmetrical, flattened, straight, herbaceous, 1–4 × 0.5–0.9 mm near the base, puberulent, tardily deciduous; petiole adaxially grooved, 8–16 mm long, puberulent; petiolar glands usually 2, one just below the lowermost pinna pair, columnar, 0.4–1.5 mm long, gland apex commonly expanded, 0.4–1.5 mm across, orbicular to oval, depressed, glabrous; rachis adaxially grooved, 80–165 mm long, puberulent with a sessile to commonly columnar gland 0.3–1.1 mm long, between most of the pinna pairs, apex commonly expanded, 0.3–0.8 mm across, orbicular, flat to depressed, glabrous, pinnae 16 to 33 pairs/leaf, 25–48 mm long, 2–6 mm between pinna pairs; paraphyllidia 0.3–1.1 mm long, commonly absent; petiolule 0.8–1.4 mm long; leaflets 40 to 70 pairs/pinna, opposite, 0.3–0.7 mm between leaflet pairs, linear, 2.5–4.1 × 0.4–0.8 mm, glabrous, lateral veins not obvious, 1 vein from the base, base oblique, obtuse, margins minutely ciliate, apex obtuse, midvein essentially central. **Inflorescence** a densely 16- to 38-flowered globose head 9–13 mm across, in terminal pseudo-paniculate clusters, the main axis to 300 mm long; peduncles 4–12 × 0.3–0.5 mm thick, puberulent; receptacle not enlarged, globose; involucre rarely a single small bract on the peduncle, early deciduous; floral bracts spatulate, 0.3–0.6 mm long, puberulent, early deciduous. **Flowers** sessile, cream; calyx 5-lobed, 1.1–2.1 mm long, lightly puberulent; corolla 5-lobed, 2.2–3.2 mm long, usually glabrous, lobes one-quarter the length of the corolla; stamen filaments 5–7 mm long, distinct; anther glands absent; ovary pubescent, stipe to 1.6 mm long. **Legumes** straight, flattened, not constricted between the seeds, oblong, 110–190 × 25–38 mm, coriaceous, transversely striated, glabrous, eglandular, dehiscent along both sutures; stipe 8–18 mm long; apex acute, beaked. **Seeds** not seen.

*Notes.*—*Senegalia phillippei* is morphologically similar to *S. hoehnei*, a species of eastern Brazil. With this

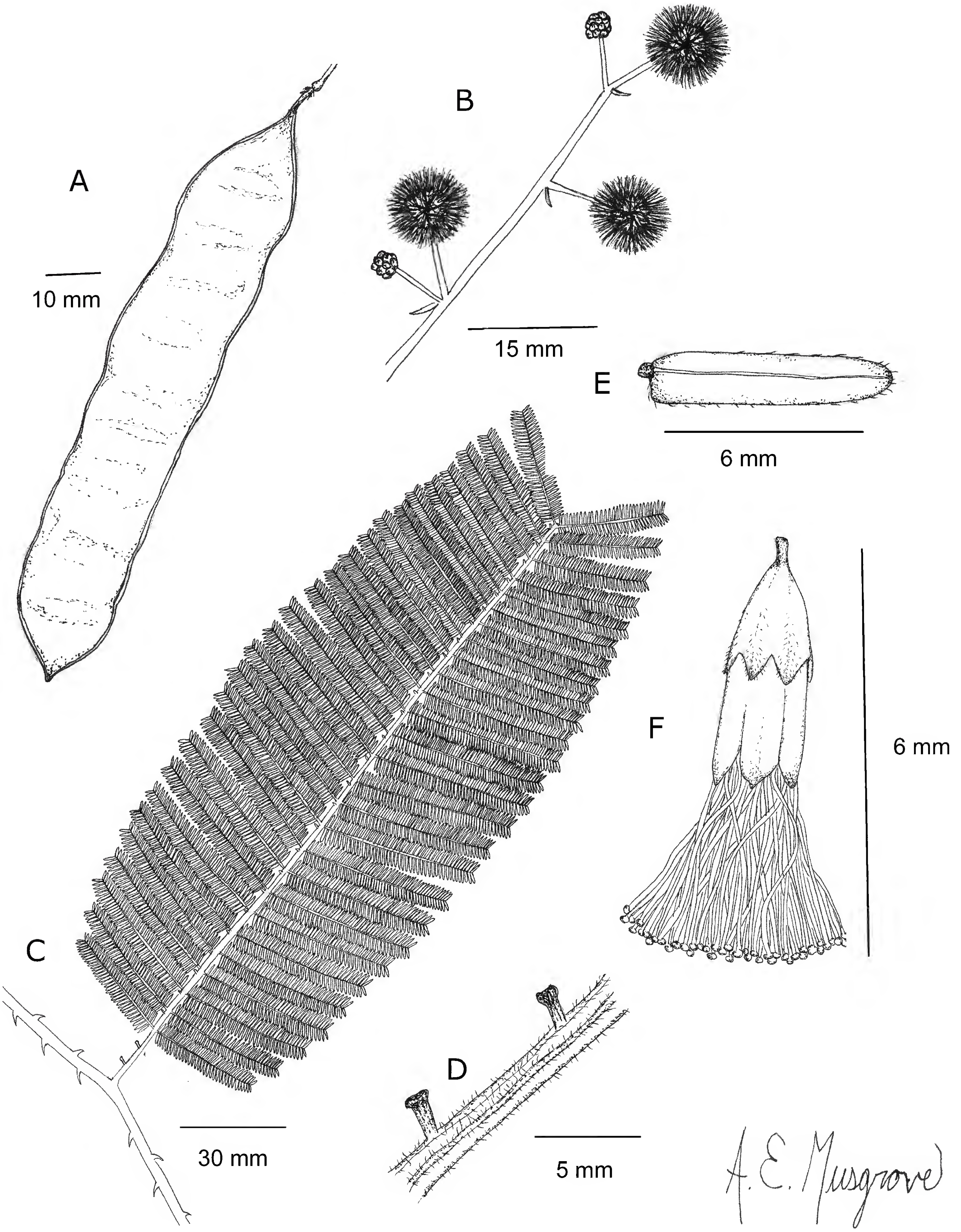
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Fig. 3. *Senegalia phillippei*. **A.** Legume; **B.** Inflorescences (portion of pseudopanicle) **C.** Leaf and stem; **D.** Petiolar glands; **E.** Lower side of leaflet; **F.** Flower (inverted). (**A–F** *S. Mori, G. Prance, J. Boeke, B. Boom 15016,* WIS).

species it shares 2 columnar petiolar glands, a large number of relatively small leaflets on the pinnae, these with central to subcentral midveins, and small flowers in small globose heads clustered into large pseudopanicles. *Senegalia phillippei* is separated from *S. hoehnei* by having the petiole, rachis, and young twigs puberulent with curled hairs to 0.5 mm long in *S. hoehnei*), and rachis glands between the ultimate 10 pinna pairs and occasionally some lower pinna pairs in *S. hoehnei*).

*Distribution and ecology.*—Moist tropical and second growth forests and thickets from near sea level to 1800 m in Brazil (Amapá and Pará states), French Guyana, Guyana, Surinam, Venezuela (Anzoátegui and Bolívar states).

*Phenology.*—Flowering Sep–Nov.

*Local names and uses.*—None known.

*Etymology.*—This species is named after L.R. Phillippe of the Illinois Natural History Survey, Champaign, who was a co-collector of the type specimen.

*IUNC Red List category.*—DD, data deficient. Probably relatively common but rarely collected (IUCN 2001).

**Paratypes: BRAZIL: Amapá:** 3 km E of Mata Indios, Río Oiapoque, 2°47'N/52°27'W, 24 Sep 1960, *H.S. Irwin, J.M. Pires & L.Y.T. Westra 48464* (B, F, NY, US); Río Araguari, Sierra do Navio, 25 Sep 1961, *J.M. Pires, W. Rodrigues & G.C. Irvine 51192* (NY, US); Río Falsino, 10 km upstream from confluence with Río Araguari, 1°0'N/51°40'W, 1 Oct 1987, *J. Pruski, D. Campbell, D. Williams, R.F. Garcia, J. Freitas, J. Cardoso &. E. Batista 3335* (MO, NY, US). **Pará:** 10 km N from the state line along BR-010, 230 m, 16 Jul 1987, *S. Tsugaru & Y. Sano 264* (MO, NY). **FRENCH GUIANA:** 40 km from the bridge on the Mahury, S of Cayenne, 4.54802N/52.14872W, 295 m, 21 Sep 2008, *C. Feuillet, A. Rossman & S. Jackman 17015* (NY); Camp No. 3, 54°1'N/2°36'W, 160 m, 26 Aug 1987, *J.J. de Granville, L.Allorge, W.J. Hahn, M. Hoff, & N. Weizman 9736* (NY); Saül, Monts La Fumée, 3°37'N/53°12'W, 200–400 m, 17 Oct 1982, *S. Mori, B. Boom, G. Prance & J. Boeke 15106* (CM, MO, NY, WIS); Saül, 3°37'N/53°12'W, 200–500 m, 12 Feb 1998, *S.A. Mori, C.A. Gracie & K.L. Purzycki 24764* (NY); Between airport and Saül, 3°37'N/53°12'W, 200 m, 29 Oct 1986, *L. Skog, C. Feuillet & A. Rossman 7121* (NY). **GUYANA:** Km 60 de la route N2 en direction de Regina, 2 Nov 1982, *F. Billiet & B. Jadin 1532* (BR); Potaro-Siparuni region, Iwokrama Rainforest Reserve, 4°45'N/59°1'W, 75–400 m, 8 Nov 1995, *D. Clarke & B. Hoffman 432* (NY); Camp 4, 220 m, 31 Aug 1987, *J.J. Granville, L. Allorge, W.J. Hahn, M. Hoff & N. Weitzman 9866* (P, US); Marudi Moutains, Mazoa Hill, 2°15'N/59°10'W, 400–450 m, 9 Nov 1982, *A.L. Stoffers et al. 217* (MO). **SURINAM:** Marowijne District, Nassau Mountains, 4°49'N/54°37'W, 500–550 m, 7 Feb 2003, *M.J. Jansen-Jacobs, U.P.D.Raghoenandan, A Grant, A. Ramharrakh, H. ter Steege & O.Bánki 6612* (NY); Banks of Tanjimama River, 14 Nov. 1944, *A.M.W. Mennega 381* (NY). **VENEZUELA: Anzoátegui:** S-facing slopes of Cerro Peonía (Cerro Los Pajaritos), above Santa Cruz, 1600–1800 m, 20 Mar 1945, *J.A. Steyermark 61574* (F, MO, VEN-n.v.); **Bolívar:** Reserva Forestal Imataca, Carretera Casa Blanca-San Martín de Turumbán, 21 May 1982, *B. Stergios, G. Aymard & O. Palacios 3837* (MO, PORT-n.v.).

## ACKNOWLEDGMENTS

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## BOOK NOTICE

Tom Kimmerer. 2015. **Venerable Trees: History, Conservation, and Biology in the Bluegrass.** (ISBN-13: 978-0813165660, hbk). University Press of Kentucky, 663 South Limestone Street, Lexington, Kentucky 40508-4008, U.S.A. (**Orders:** www.kentuckypress.com, 1-800-53715487). $39.95, 288 pp., 120 b&w photos, 118 color photos, 29 maps, 1 figure, 7" × 10".

*From the Publisher*: When the first settlers arrived in the Bluegrass region of Kentucky, they found an astonishing landscape of open woodland grazed by vast herds of bison. Farmers quickly replaced the bison with cattle, sheep, and horses, but left many of the trees to shade their pastures. Today, central Kentucky and central Tennessee still boast one of the largest populations of presettlement trees in the nation, found in both rural and urban areas.

In *Venerable Trees: History, Biology, and Conservation in the Bluegrass,* Tom Kimmerer showcases the beauty, age, size, and splendor of these ancient trees and the remaining woodland pastures. Documenting the distinctive settlement history that allowed for their preservation, Kimmerer explains the biology of Bluegrass trees and explores the reasons why they are now in danger. He also reveals the dedication and creativity of those fighting to conserve these remarkable three-hundred- to five-hundred-year-old plants—from innovative, conscientious developers who build around them rather than clearing the land to farmers who use lightning rods to protect them from natural disasters.

Featuring more than one hundred color photographs, this beautifully illustrated book offers guidelines for conserving ancient trees worldwide while educating readers about their life cycle. *Venerable Trees* is an informative call to understand the challenges faced by the companions so deeply rooted in the region's heritage and a passionate plea for their preservation.

**Tom Kimmerer** is chief scientist at Venerable Trees, Inc., a nonprofit dedicated to the conservation of woodland pastures and ancient trees in the Bluegrass. Trained as a tree physiologist and forest scientist, he has been a researcher and teacher in the United States, Indonesia, and Malaysia.

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# *NAUTILOCALYX RUGOSUS* (GESNERIACEAE), A NEW SPECIES FROM THE RÍO CENEPA WATERSHED (AMAZONAS, PERU)

Rocio del P. Rojas G.
*Herbario Selva Central Oxapampa (HOXA)*
*Prolongación Bolognesi Mz. E, Lote 6*
*Oxapampa-Pasco, PERU*
*gesneria@yahoo.com*

John L. Clark
*Department of Biological Sciences*
*The University of Alabama, Box 870345*
*Tuscaloosa, Alabama 35487 U.S.A. and*
*Science Department, The Lawrenceville School*
*2500 Main St., Lawrenceville, New Jersey 08648, U.S.A.*
*jlc@ua.edu*

## ABSTRACT

A recent botanical inventory of the sandstone outcrops in Tayu mujaji of the río Cenepa watershed of northeastern Peru (Amazonas province) has resulted in the discovery of a new species, **Nautilocalyx rugosus** R. Rojas & J.L. Clark of the Gesneriaceae (tribe: Gesnerieae and subtribe: Columneinae). The new species is distinguished from other species in the genus by a saxicolous habit, basal corolla spur, and markedly bullate leaves with a single elongate trichome at the apex of each bullation. The habitat of the type locality is a blackwater river on quartz sandstone in an area known locally as "cerro de los Tayus" and represents one of most botanically unexplored regions of Peru.

Key Words: *Nautilocalyx*, Gesneriaceae, Sandstone, Cenepa watershed

## RESUMEN

El inventario botánico realizado recientemente en el Tayu mujaji (Amazonas, Perú) en la cuenca del río Cenepa, sobre los afloramientos de roca de arenisca, ha dado como resultado el descubrimiento de una nueva especie, **Nautilocalyx rugosus** R. Rojas & J.L. Clark de la familia Gesneriaceae (tribu: Gesnerieae y subtribu: Columneinae). La nueva especie se distingue de las otras especies del género por un conjunto de caracteres que incluyen el hábito saxícola, corola con espolón basal, y hojas marcadamente ampolladas, con un solo tricoma alargado en el ápice de cada ampolla. La localidad tipo es conocida localmente como "cerro de los Tayus" y representa una de las áreas botánicamente inexploradas del Perú.

Palabras Clave: *Nautilocalyx*, Gesneriaceae, roca de arenisca, cuenca del río Cenepa

## INTRODUCTION

The genus *Nautilocalyx* Linden ex Hanst., includes 58+ species (Möller & Clark 2013; Feuillet 2008) and is neotropical in distribution from Mexico to Peru, the Guianas and Amazonian Brazil. The center of diversity for *Nautilocalyx* is the Venezuelan Guayana where more than 19 species occur (Feuillet 2008; Feuillet & Steyermark 1999). There are 12 species of *Nautilocalyx* in Peru (Kvist et al. 2005) and five have been documented in the río Cenepa watershed of northeastern Peru (Rojas 2010).

*Nautilocalyx* is a member of the tribe Gesnerieae and subtribe Columneinae, which is the largest subtribe with 24 genera and 21% of the total species diversity in the family (Weber et al. 2013). Characters that define most species of *Nautilocalyx* include a terrestrial habit, isophyllous leaves, subglobose capsule, and infundibular corolla (Wiehler 1983). Recent molecular-based phylogenetic analyses with a broad taxon sampling of *Nautilocalyx* strongly support that it lacks monophyly (Mora and Clark, in press). A new generic classification based on recent phylogenetic results is in the process of being published (Mora & Clark in press; Mora & Clark 2014) and we predict that *Nautilocalyx rugosus* will nest with other traditionally recognized members of *Nautilocalyx* that are also found in the Amazon Basin or eastern slopes of the Andes.

## TAXONOMIC TREATMENT

**Nautilocalyx rugosus** R. Rojas & J.L. Clark, sp. nov. (**Figs. 1, 2**). Type: PERU. Amazonas: Bagua province, Imaza district, lower slopes of Cerro Tayu, ca., 1 hour from Chiriaco, vegetation "Kampau" or "Campau," soil with thick humus layer, 05°15'56"S, 78°22'07"W, 900 m, 28 October 2012, *H. van der Werff, Rocío Rojas, Luis Valenzuela, Gerry Shareva, Ricardo Apanu, Alcides Roca & Augusto Reyes Barrantes 24654* (holotype: HOXA; isotypes: HUT, MO, MOL, USM).

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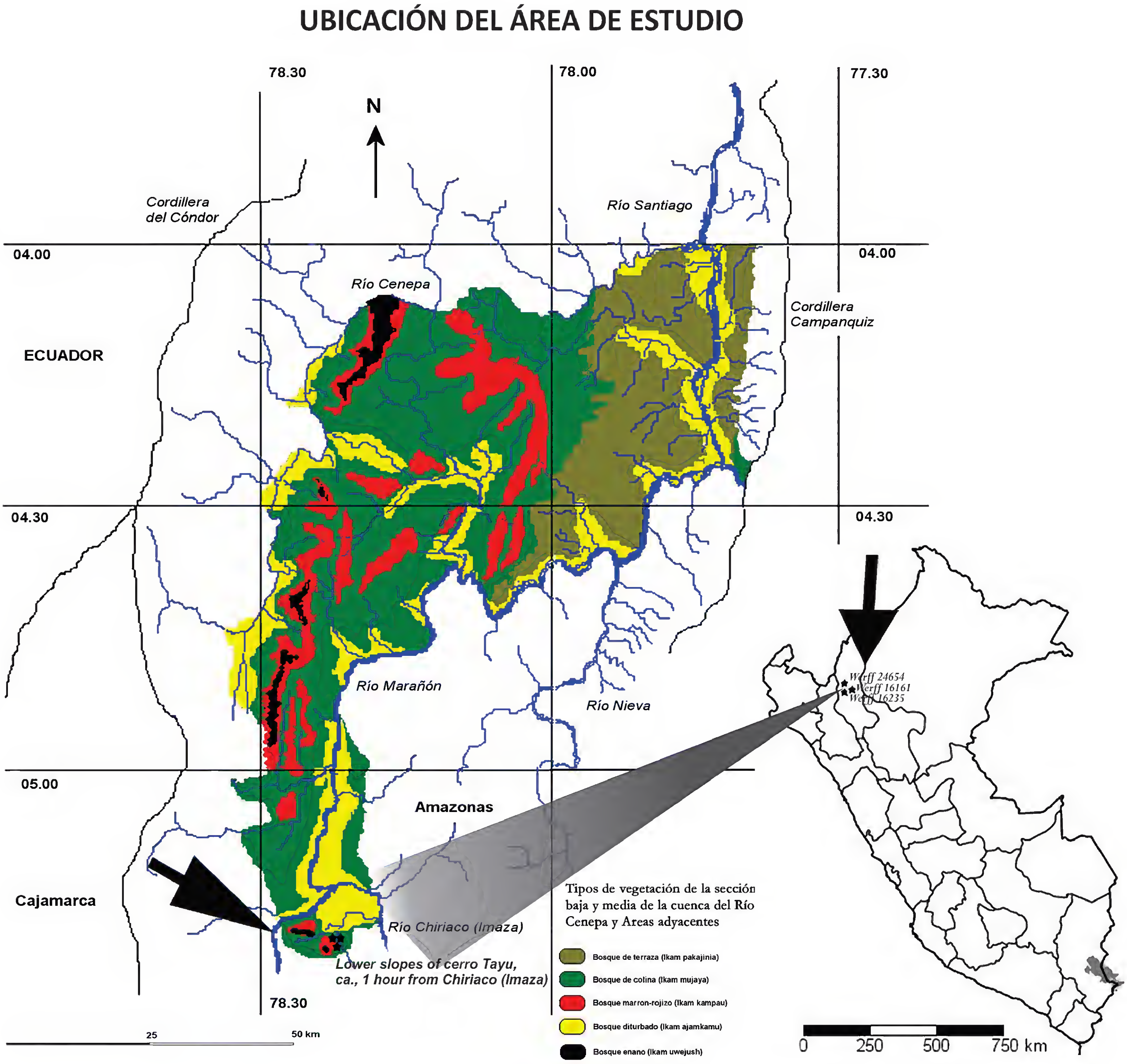
UBICACIÓN DEL ÁREA DE ESTUDIO
78.30
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Río Marañón
Río Nieva
Werff 24654
Werff 16161
Werff 16235
05.00
Amazonas
Cajamarca
Río Chiriaco (Imaza)
Lower slopes of cerro Tayu, ca., 1 hour from Chiriaco (Imaza)
78.30
25
50 km
Tipos de vegetación de la sección baja y media de la cuenca del Río Cenepa y Areas adyacentes
Bosque de terraza (Ikam pakajinia)
Bosque de colina (Ikam mujaya)
Bosque marron-rojizo (Ikam kampau)
Bosque diturbado (Ikam ajamkamu)
Bosque enano (Ikam uwejush)
0
250
500
750 km

**Fig. 1. Distribution of *Nautilocalyx rugosus* R. Rojas & J.L. Clark. Arrows indicate general region of collections and specific collections are indicated by asterisks "*". (map reproduced from Vásquez et al. 2010 and reprinted with permission from Missouri Botanical Garden Press).**

Differs from other species in the genus by a saxicolous habit, basal corolla spur, and bullate leaves with a single elongate trichome at the apex of each bullation.

**Saxicolous herb;** appressed to rock wall, stems short, 5–10 cm long, greenish-brown, rhizomes succulent, terete to slightly sulcate, densely tomentose with uniseriate trichomes; adventitious roots present on the stems. **Leaves** opposite, subequal to slightly unequal in a pair, petiolate; petioles terete, 4–20 mm long, tomentose; blades obovate to narrowly oblong, 4.5–7.5 × 2.2–3.8 cm, base symmetrical to slightly oblique, rounded to slightly cordate, apex rounded, margin crenate with broad shallow teeth, ciliated along margins, adaxially dark green to light green when fresh and dark brown when dry, markedly bullate with elongate trichome at apex of each bullation, bullae 1–3 mm high, blades coriaceous and membranous when dry, abaxially purple, reticulated, mostly tomentose on veins. **Inflorescence** a reduced pair-flowered cyme, flowers appearing clustered in leaf axils, prophyll lanceolate; peduncle 2–3 mm long, in upper leaf axils, 1–5 mature flowers per inflorescence; pedicels erect, 9–15 mm long, reddish, densely pilose. **Calyx** lobes fused at base and appearing free, narrowly ovate, 5–7(–11) mm long, apex narrowly acute, margins with sparse deep serrations, erect, mostly

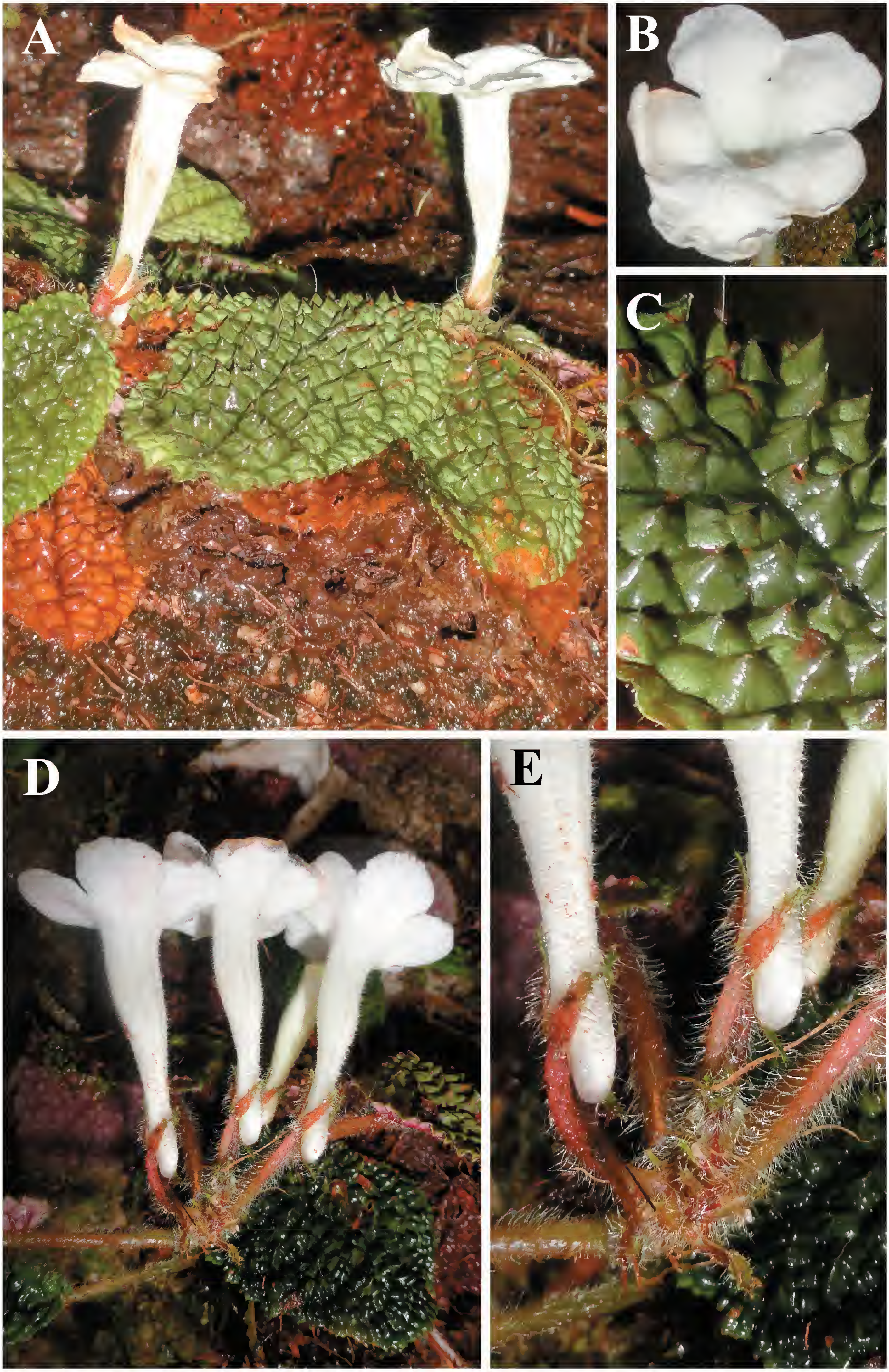

Fig. 2. *Nautilocalyx rugosus* R. Rojas & J.L. Clark. **A.** Habit. **B.** Corolla lobes. **C.** Enlargement of leaf surface showing bullae with elongated trichome on top of each bullation. **D.** Corolla tube. **E.** Corolla spur. (A–E photographic images of the holotype, *H. van der Werff et al. 24654*).

light red with green towards apex, densely pilose on outer surface and glabrous on inner surface. **Corolla** posture slightly oblique relative to the calyx, 2.5–4 cm long, tube funnelform, spurred at base, spur 3–5 mm long, base-region 2–3 mm in diameter, mid-region 5–7 mm in diameter, throat 10–12 mm wide at apex, uniformly white, outer surface of corolla tube pilose, throat sparsely pilose, limb glabrous; limb bilaterally symmetrical, lobes reflexed to patent, nearly equal, lobes suborbicular; upper two lobes 6-8 × 5–10 mm, slightly crenate; lower three lobes 10–11 × 10–11 mm. **Androecium** with 4 stamens, didynamous, included; filaments flat, curved at anthesis, adnate to the base of the corolla, free for 10–18 mm, filaments glabrous; anthers broader than long, 0.7 × 1.0 mm, dehiscing by longitudinal slits; staminode absent. **Gynoecium** with dorsal nectary gland, glabrous, ca. 1 mm long; ovary ovoid, 3 × 1 mm, densely sericeous, style 2.5 cm long, with glandular capitate trichomes; stigma bilobed with glandular capitates trichomes. **Fruits** not observed.

*Nautilocalyx rugosus* is characterized by a saxicolous habit, succulent to fleshy leaf blades, and conspicuous bullae with a single erect trichome on the apex of each bullation (Fig. 2C). The conspicuous bullations appear like blisters and reach 3 mm in height. Other *Nautilocalyx* species with bullate leaves are *Nautilocalyx bullatus* (Lem.) Sprague and *N. pemphidius* L.E. Skog. *Nautilocalyx rugosus* is differentiated by elongate shoots (vs. basal rosette in *N. pemphidius*) and non-fimbriate corolla margins (Fig. 2B) (vs. fimbriate corolla margins in *N. bullatus*).

*Distribution and habitat.*—*Nautilocalyx rugosus* is endemic to the Tayu mujaji region (Dept. Amazonas, Prov. Bagua) of northwestern Peru (Fig. 1). Cerro Tayu is a low sandstone mountain largely covered with vegetation that is referred to locally by the Awajún Indigenous people as "Campau" or "Kampau" and corresponds to an area between 650 and 1200 m. The soils of this region are characterized by a thick layer of humus (litter) and shallow soils. The area is not suitable for agriculture because of the abundance of exposed sandstone and shallow soils (Vásquez et al. 2010). *Nautilocalyx rugosus* is endemic to this region and is mostly found on cliffs or exposed sandstone. Other plants that grow sympatrically with *N. rugosus* include *Alloneuron ronliesneri* B. Walln. (Melastomataceae), *Monolena primuliflora* Hook. f. (Melastomataceae), *Triolena pluvialis* (Wurdack) Wurdack (Melastomataceae), *Peperomia* sp. (Piperaceae), *Pilea* sp. (Urticaceae), *Pterozonium reniforme* (Mart.) Fee (Pteridaceae), *Guzmania gracilior* (André) Mez (Bromeliaceae), *Cyathea thelypteroides* A.R. Sm. (Cyatheaceae), and *Trichomanes pilosum* Raddi (Hymenophyllaceae). This area is considered one of the most botanically unexplored regions of Peru (Vasquez et al. 2010) and another recently described species from the Gesneriaceae that is a local endemic is *Cremosperma inversum* B.R. Keener & J.L. Clark (Keener & Clark 2014).

*Etymology.*—The specific epithet is in reference to the rugose surface of the leaf blades that are deeply furrowed like a wrinkle.

*Conservation and IUCN Red List category.*—*Nautilocalyx rugosus* is geographically limited to a small area in the Cenepa watershed of northeastern Peru. According to the IUCN Red List criteria (IUCN 2012) for limited geographic range (B2a, less than 10 km$^2$ and known to exist at only a single location), *Nautilocalyx rugosus* should be listed in the category CR (Critically Endangered).

Additional specimens examined: **PERU. Amazonas:** Bagua province, Imaza district, Quebrada Almendro, along road and in forest on sandstone, 05°14'40"S, 78°21'34"W, 400 m, 17 Mar 2001, *H. van der Werff, Rodolfo Vásquez & Bruce Gray 16161* (MO); sandstone face, Cerro Tayu, ca. 1 hour from Chiriaco, 05°15'56"S, 078°22'07"W, 800 m, *H. van der Werff et al. 16235* (MO, USM).

## ACKNOWLEDGMENTS

The first author is grateful to the Missouri Botanical Garden (MO) and the Herbario Selva Central (HOXA) for access to their collections; El Servicio Nacional de Áreas Naturales Protegidas por el Estado (SERNANP) for research permits and authorization to work in Amazonas (Peru); Olga Martha Montiel for her support through Missouri Botanical Garden Peru Program; Rodolfo Vasquez for suggestions on an early version of the manuscript; Henk van der Werff for his enormous contributions to botanical research in Peru and comments on the manuscript. Ricardo Apanú is gratefully acknowledged for guiding us throughout the floristic inventory of the río Cenepa watershed and for bringing us to Tayu. We also thank fellow field botanists Luis Valenzuela, Alcides Roca and Gerry Shareva who assisted the 2012 expedition to Tayu Hill. Support for JLC was provided by the National Science Foundation (DEB-0841958 and DEB-0949169). We thank the Missouri Botanical Garden Press for allowing us to reproduce the map of the Cenepa watershed (Figure 1).

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# BOOK NOTICE

Mary Siisip Geniusz. 2015. **Plants Have So Much to Give Us, All We Have to Do is Ask: Anishinaabe botanical teachings.** (ISBN-13: 978-0-8166-9676-5, pbk). University of Minnesota Press, 111 Third Avenue South, Minneapolis, Minnesota 55401, U.S.A. (**Orders:** www.upress.umn.edu). $22.95, 344 pp., 37 b&w photos, 7" × 10".

*From the Publisher*: Mary Siisip Geniusz has spent more than thirty years working with, living with, and using the Anishinaabe teachings, recipes, and botanical information she shares in *Plants Have So Much to Give Us, All We Have to Do Is Ask*. Geniusz gained much of the knowledge she writes about from her years as an oshkaabewis, a traditionally trained apprentice, and as friend to the late Keewaydinoquay, an Anishinaabe medicine woman from the Leelanau Peninsula in Michigan and a scholar, teacher, and practitioner of native ethnobotany. Keewaydinoquay published little, yet Geniusz has carried on her legacy by making this knowledge accessible to a broader audience.

Geniusz teaches the ways she was taught—through stories. Sharing the traditional stories she learned at Keewaydinoquay's side as well as stories from other American Indian traditions and her own experiences, Geniusz brings the plants to life with narratives that explain their uses, meaning, and history. Stories such as "Naanabozho and the Squeaky-Voice Plant" place the plants in cultural context and illustrate the belief in plants as cognizant beings. Covering a wide range of plants, from conifers to cattails to medicinal uses of yarrow, mullein, and dandelion, Geniusz explains how we can work with these botanical beings to create food, simple medicines, and practical botanical tools.

*Plants Have So Much to Give Us, All We Have to Do Is Ask* makes this botanical information available to native and nonnative healers and educators and emphasizes the Anishinaabe culture that developed the knowledge and practice.

**Mary Siisip Geniusz** is of Cree and Métis descent and an oshkaabewis, a traditionally trained apprentice, of the late Keewaydinoquay. She holds a master's degree in liberal studies from the University of Wisconsin–Milwaukee and has taught university courses on ethnobotany, American Indian studies, and American multicultural studies.

# CORRIGENDUM:
# NEW COMBINATIONS IN *CORYPHANTHA* AND *ESCOBARIA* (CACTACEAE)

Root Gorelick

*Department of Biology, School of Mathematics & Statistics, and*
*Institute of Interdisciplinary Studies*
*Carleton University, 1125 Raven Road*
*Ottawa, Ontario K1S 5B6, CANADA*
*Root.Gorelick@carleton.ca*

In the previous issue (9, no. 1, 2015) of this journal, I provided two new combinations—*Coryphantha sneedii* var. *orcuttii* and *Escobaria sneedii* var. *orcuttii*—based on the same basionym, *Escobaria orcuttii* Boed. (Gorelick 2015). Shortly thereafter, David Hunt kindly informed me that this contravenes the International Code of Nomenclature (Melbourne Code) Article 36.2 (McNeill et al. 2012) [previously the International of Botanical Nomenclature (Vienna Code) (McNeill et al. 2006) Article 34.2], which states:

> When, on or after 1 January 1953, two or more different names based on the same type are proposed simultaneously for the same taxon by the same author (so-called alternative names), none of them is validly published.

Therefore, I hereby correct this error by only proposing one of those two combinations, namely:

**Coryphantha sneedii** var. **orcuttii** (Boed.) Gorelick, comb. et stat. nov. BASIONYM: *Escobaria orcuttii* Boed., Ein Mammillarien Vergleichs-Schlüssel 17. 1933. TYPE: U.S.A. NEW MEXICO. Hidalgo Co.: Peloncillo Mountains, near Granite Pass, Mar 1926, *J.N. Rose s.n.* (LECTOTYPE, designated by Benson 1969: 26: DS).

*Coryphantha strobiliformis* (Poselg.) Moran var. *orcuttii* (Rose ex Orcutt) L.D. Benson, Cacti Ariz. ed. 3, 26. 1969.
*Coryphantha orcuttii* (Rose ex Orcutt) Zimmerman, Cact. Succ. J. (US) 44:156. 1972.
*Coryphantha organensis* Zimmerman, Cact. Succ. J. (US) 44:114. 1972.
*Escobaria organensis* (Zimmerman) Castetter, P. Pierce & K.H. Schwer., Cact. Succ. J. (US) 47:60. 1975.
*Escobaria sneedii* Britton & Rose subsp. *orcuttii* (Boed.) Lüthy, Kakt. and. Sukk. 50:278. 1999.
*Escobaria sneedii* Britton & Rose subsp. *organensis* (Zimmerman) Lüthy, Kakt. and. Sukk. 50:278. 1999.

That previous paper in this journal (Gorelick 2015) was predicated on (1) *Escobaria orcuttii* being a variety, rather than a subspecies, because of sympatry with other taxa and (2) *Escobaria* Britton & Rose being either a subgenus or section of *Coryphantha* (Engelm.) Lem. Many European botanists have abandoned use of the rank variety ('varietas'). The Cactaceae Working Party of the International Organization for Succulent Plant Study (IOS) has also abandoned use of the rank variety, albeit apparently without complete consensus as reflected by the opening quote in that paper (Hunt 1999: 23; quoting Meregalli 1993):

> Probably one category only, below the species, would do for the great majority of infraspecific taxa, although in (possibly very few) cases some striking variants of low systematic value (i.e. not related to geographic/ecological isolation) may warrant recognition.

If *Escobaria orcuttii* is considered a subspecies of *Coryphantha sneedii*, which I do not advocate because of sympatry with the type variety/subspecies of *Coryphantha sneedii* at Anthony's Nose, then someone will have to propose the new combination *Coryphantha sneedii* subsp. *orcuttii*. If *Escobaria orcuttii* is considered a variety of *Escobaria sneedii*, which I do not advocate because of lack of consistent morphological differences between *Coryphantha* and *Escobaria*, then someone will have to propose the new combination *Escobaria sneedii* var. *orcuttii*, which was a nomen nudum in Gorelick (2015). Another plausible combination for this taxon, one for which I do not agree with the subspecies designation nor the choice of genus, would be *Escobaria sneedii* subsp. *orcuttii* (Boed) Lüthy, which has been validly published. A final possibility is that *Coryphantha orcuttii* is merely a form ('forma') of *Coryphantha sneedii*. But I am reluctant to invoke this last option without spending more time in Luna and Hidalgo Counties of New Mexico, especially given the seemingly consistent morpho-

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logical differences between *Coryphantha sneedii* and *Coryphantha orcuttii* in terms of number of shoots, size of shoots, and length of central spines (Gorelick 2015 and references therein).

## ACKNOWLEDGMENTS

I greatly appreciate David Hunt's input and help with interpretation of the International Code of Nomenclature.

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# *PSEUDHAPLOCRICUS HEXANDRUS* GEN. ET SP. NOV. (COMMELINACEAE) IN MID-TERTIARY DOMINICAN AMBER

George O. Poinar, Jr.
*Department of Integrative Biology*
*Oregon State University*
*Corvallis, Oregon 97331, U.S.A.*
*poinarg@science.oregonstate.edu*

Kenton L. Chambers
*Department of Botany and Plant Pathology*
*Oregon State University*
*Corvallis, Oregon 97331, U.S.A.*

## ABSTRACT

**Pseudhaplocricus hexandrus** gen. et sp. nov. (Commelinaceae) is described from Mid-Tertiary amber from the Dominican Republic. The trimerous, staminate flower is characterized by a short pedicel, 2 perianth whorls with 3 glabrous, free sepals and 3 glabrous, free, deliquescent petals. The 6 fertile, glabrous stamens are of equal length; their apparent arrangement in a single whorl is due to fusion, during floral development, of the 2 whorls of 3 which are characteristic of Commelinaceae. The filaments are broadened and united basally. The anthers are bilocular, dorsifixed and dehisce longitudinally. The fossil establishes a mid-Tertiary lineage of Commelinaceae in Mesoamerica.

## RESUMEN

Se describe **Pseudhaplocricus hexandrus** gen. et sp. nov. (Commelinaceae) del ámbar del Terciario Medio de la República Dominicana. Las flores trímeras, estaminadas se caracterizan por un pedicelo corto, 2 verticilos de perianto con tres sépalos libres glabros y tres pétalos libres, glabros delicuescentes. Los seis estambres fértiles son de igual longitud; su ordenación aparente en un verticilo es debida a su fusión durante el desarrollo floral, de dos verticilos de los tres que son característicos de las Commelinaceae. Los filamentos están ensanchados y unidos basalmente. Las anteras son biloculares, dorsifijas y dehiscencia longitudinal. El fósil establece una línea del Terciario Medio de Commelinaceae en Mesoamérica.

## INTRODUCTION

Amber from the Dominican Republic has provided a rare glimpse of the flora that existed in the West Indies during the mid-Tertiary. The present study describes a fossil member of the Commelinaceae, a pantropical family of annual or perennial monocotyledonous herbs with some 650 species and 42 genera. While distributed worldwide, the family is most abundant in the tropics and subtropics with centers of diversity in the Americas, Africa and India (Faden 1998; Hardy & Faden 2004). Some species of Commelinaceae, such as Dayflowers (*Commelina* spp.) and Spiderworts (*Tradescantia* spp.) are widespread and cultivated as garden, greenhouse, basket and border plants for their colorful flowers and leaf characters (Bailey 1949).

Only two previously known fossil Commelinaceae have been reported. One is a fossil flower, *Commelinacites dichorisandroides* Caspary, in Eocene Baltic amber (Caspary 1880; Conwentz 1886), and the other includes leaves and fruits assigned to the genus *Pollia* from the Middle Miocene Ngorora Formation in Kenya (Jacobs & Kabuye 1989). The present specimen is the first New World fossil of the family.

## MATERIALS AND METHODS

The fossil originated from amber mines in the northern mountain range (Cordillera Septentrional) of the Dominican Republic between Puerto Plata and Santiago. Amber from mines in this region was produced by the leguminous tree *Hymenaea protera* (Poinar 1991). Dating of Dominican amber is still controversial, with the youngest proposed age of 20–15 Ma based on foraminifera (Iturralde-Vincent & MacPhee 1996) and the oldest of 45–30 Ma based on coccoliths (Cépek in Schlee 1990). These are considered minimum dates since they are based on microfossils in the strata containing the amber. Most of the amber is secondarily deposited in turbiditic sandstones of the Upper Eocene to Lower Miocene Mamey Group (Draper et al. 1994). Dilcher et al. (1992) stated that "…the amber clasts, from all physical characteristics, were already matured amber at the time of redeposition into marine basins. Therefore, the age of the amber is greater than Miocene and quite likely is as early as late Eocene." The issue is further complicated by the discovery of Early Oligocene amber in Puerto Rico

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and Maastrichtian-Paleocene amber in Jamaica (Iturralde-Vinent 2001), showing that amber from a range of deposits occurs in the Greater Antilles. The Dominican amber forest was characterized by Poinar and Poinar (1999) based on various animal and plant fossils.

Observations and photographs were made with a Nikon SMZ-10 R stereoscopic microscope and Nikon Optiphot compound microscope with magnifications up to 600 X. Helicon Focus Pro X64 was used to stack photos for better clarity and depth of field.

## DESCRIPTION

**Pseudhaplocricus** Poinar & K.L. Chambers, gen. nov. (**Figs. 1–4**). Type Species: *Pseudhaplocricus hexandrus* Poinar & K.L. Chambers, sp. nov.

Flower actinomorphic, staminate, pistillode none; perianth with 2 whorls, the outer whorl of 3 glabrous, free sepals (Fig. 1); inner whorl petaloid with 3 free, glabrous, deliquescent petals lacking a fringed margin (Fig. 2); fertile stamens 6, of equal length, basally connate in a single whorl at maturity although developing from the bicyclic androecium characteristic of Commelinaceae (Hardy et al. 2009); anthers bilocular, dorsifixed, dehiscing longitudinally, with narrow connective and spiral-reticulate secondary endothecial thickenings (Fig. 3); filaments glabrous, broadened at base (Figs. 3, 4).

*Etymology.*—From the Greek "pseudo," false, "haploos," single, and "krikos," ring, in reference to the single whorl of 6 stamens originating from 2 whorls of 3.

**Pseudhaplocricus hexandrus** Poinar & K.L. Chambers, sp. nov. Type: HISPANIOLA. Dominican Republic: amber mine in the northern mountain ranges (Cordillera Septentrional), 1986, *unknown amber miner s.n.* (holotype: catalog number Sd-9-118; deposited in the Poinar amber collection maintained at Oregon State University, Corvallis, Oregon 97331, U.S.A.).

Flower diameter 3.3 mm across opposing anthers; calculated diameter based on detached petals 8.5 mm; pedicel length 0.5 mm; sepals ovate-elliptic, length 0.7(0.5–0.9) mm, width at base 1.0(0.9–1.2) mm; petals detached in amber, partially liquefied, clawed, only 1 outstretched, length 4.3 mm, length of claw 0.9 mm; stamen filament length 0.7(0.5–1.0) mm, ring of connected filament bases 1.0 mm in diameter; anther length 1.0(0.9–1.1) mm, pistil 0.

*Etymology.*—From the Greek "hexa," six, and "andro," man, in reference to the 6 fertile stamens.

## DISCUSSION

The original color of the petals and sepals is unknown, since fading of colors occurs over time in amber. Characters of *Pseudhaplocricus hexandrus* that are consistent with those of the family Commelinaceae are: unisexual male flower with 2 trimerous perianth whorls (3 sepals and 3 deliquescent petals), 6 fertile stamens with glabrous filaments and dorsifixed anthers that dehisce longitudinally, and abortion of the gynoecium (Faden 1998; Hardy & Faden 2004).

Based on the classification of Faden and Hunt (1991), the fossil falls in the tribe Tradescantieae Meisner of the subfamily Commelinoideae Brückner. This tribe comprises the New World subtribes Dichorisandrinae Pichon, Thyrsantheminae Faden & D. Hunt, and Tradescantiinae Rohw. It includes species from Mexico, Central America, the Caribbean, and South America. Genera in the above subtribes with characters similar to *Pseudhaplocricus hexandrus* are *Tradescantia* L., whose flowers are long-pedicelled with some or all filaments bearded, *Callisa* Loefl., whose species mostly have 1–3 stamens, *Tripogandra* Raf., which has zygomorphic flowers, *Cochliostema* Lem., and *Geogenanthus* Ule, which have fringed petals. *Siderasis* and *Dichorisandra* are sister genera in the subtribe Dichorisandrinae (Evans et al. 2000) which are noteworthy since both contain species with actinomorphic flowers, entire petals, and six glabrous stamens with longitudinally dehiscent anthers as in *Pseudhaplocricus*. *Siderasis* consists of one Brazilian species, *Siderasis fuscata* (Lodd.) H.E. Moore. The anther connectives of *Siderasis*, however, are broader than in *Pseudhaplocricus*, and the degree of filament fusion, if any, in *Siderasis* has not been well studied with the microscope but would be slight relative to length of the filaments in the mature flowers. *Dichorisandra* consists of over 40 species, second in the New World only

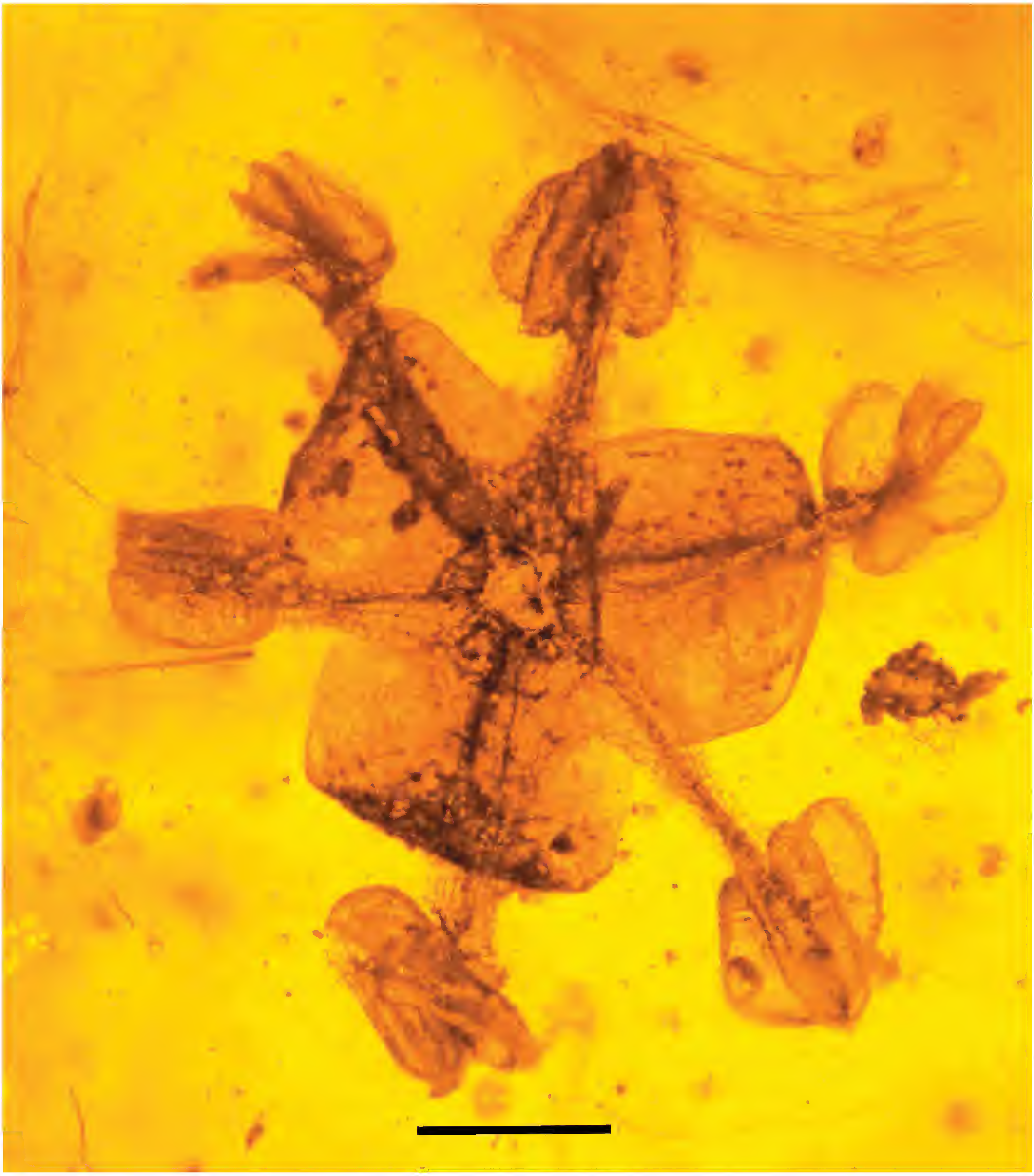

**Fig. 1.** ***Pseudhaplocricus hexandrus*. Apical view of flower, showing 3 sepals and 6 fertile stamens arranged in a single whorl. Scale bar = 0.6 mm.**

to *Tradescantia*, and is distributed from tropical South America to the Caribbean. Although zygomorphy and poricidal anther dehiscence prevail in the genus, there are some plesiomorphic members with actinomorphic flowers and longitudinal anther dehiscence (Aona et al. 2012). All members have extremely narrow anther connectives like *Pseudhaplocricus*, although the anthers in most *Dichorisandra* taxa are proportionally longer relative to the filaments. Additionally, most members of *Dichorisandra* have very short pedicels. Basal fusion of the filaments has been documented for at least two members of the genus, although in these instances the filaments also are fused to the petals.

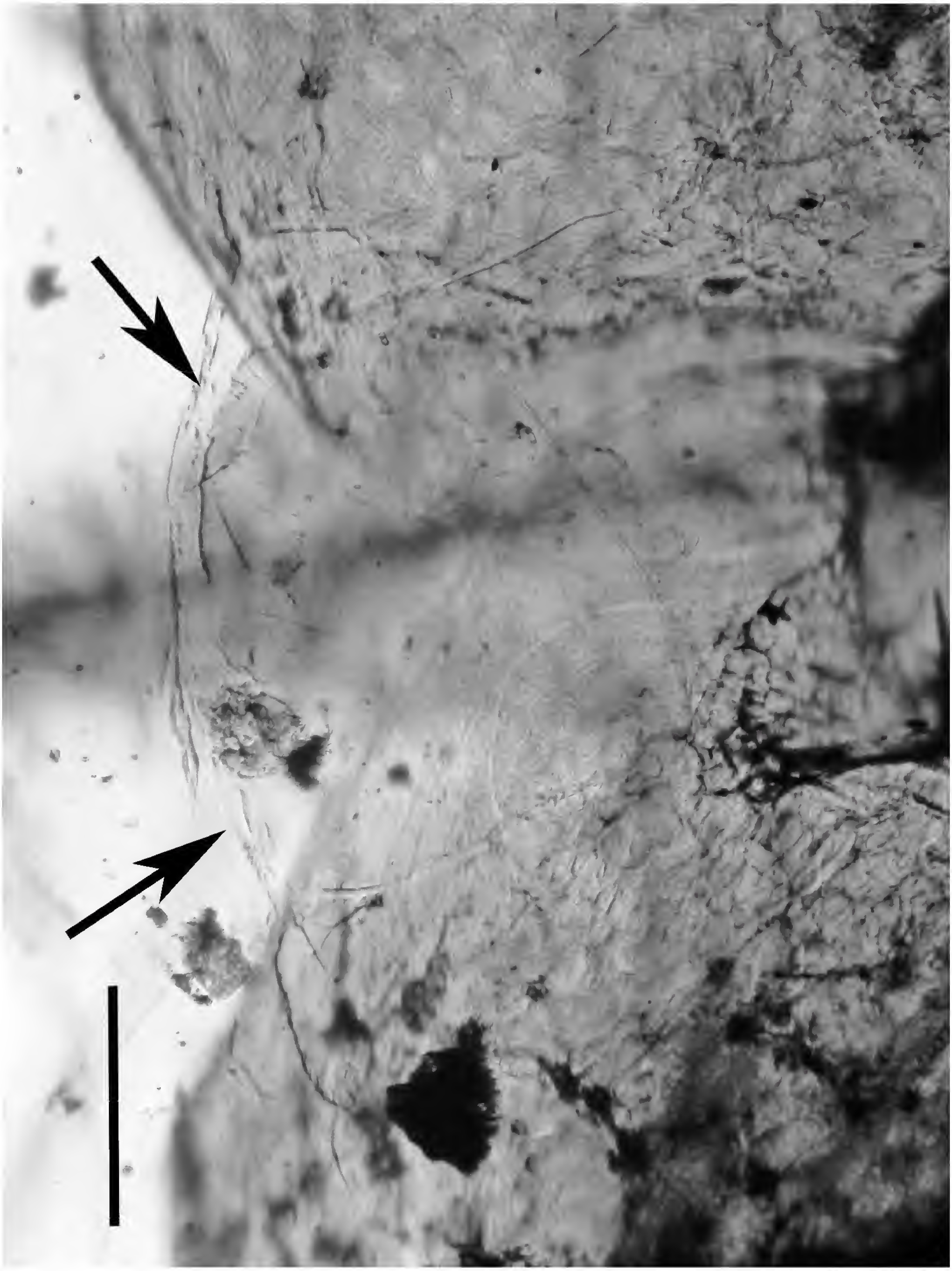

Fig. 2. *Pseudhaplocricus hexandrus*. Remains of detached, deliquescent petal. Arrows show smooth outer margin of petal. Scale bar = 0.2 mm.

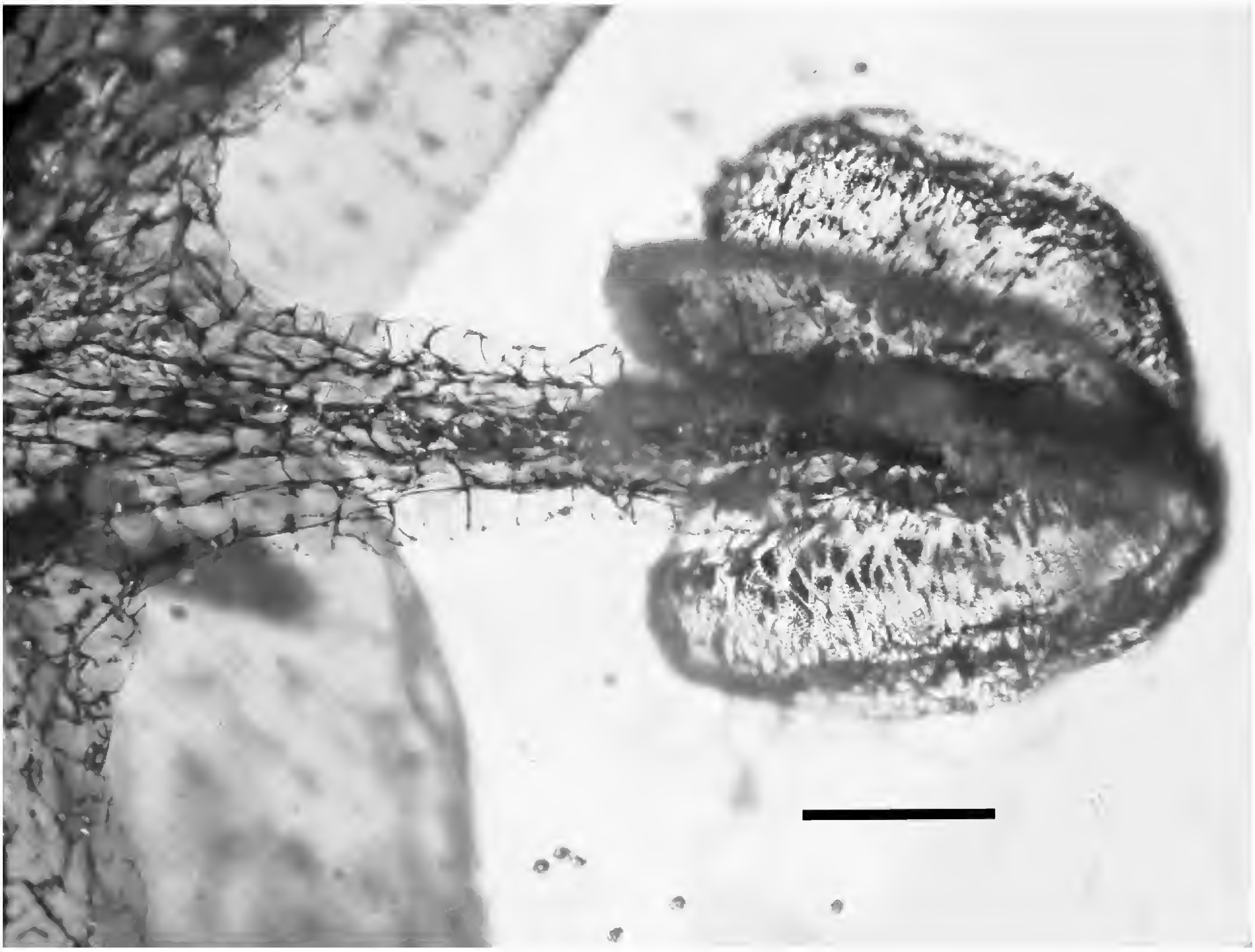

**Fig. 3.** ***Pseudhaplocricus hexandrus*****. Stamen showing bilocular anther and glabrous filament whose cells appear empty, due perhaps to enlarged vacuoles. Scale bar = 0.3 mm.**

While many flowers in the Commelinaceae are considered to be insect-pollinated, none are known to produce nectar, which means that the only reward for potential pollinators is the pollen itself. Pollination in the Commelinaceae is mainly carried out by social and solitary bees and syrphid flies. The flowers attract insects by visual aids, e.g., color of foliage and flowers, fringed margins on the petals, filament hairs, or by various fragrances (Faden 1992). Any features of the flowers that make pollen more accessible would be advantageous.

The tissue connecting the filaments forms a ring around the center of the flower in *Pseudhaplocricus*. It is possible that this dish-like structure provided mechanical support for the weight of a pollinator. From such a perch, pollinators could easily reach the relatively large anthers on the outstretched filaments. In the case of the Australian *Pollia crispata* (R. Br.) Benth., the petals act as landing platforms for bees and flies (Williams & Walker 2003). The center of the flower of *Pseudhaplocricus hexandrus* is depressed and contains no trace of an ovary or pistillode. It is tempting to speculate that it contained some type of liquid reward for pollinating insects, even though nectar production is unknown in extant flowers of the family (Faden 1992). Insect pollinators of *Pollia crispata* in Australia are syrphid flies and halictid and trigonid bees (Williams & Walker 2003). Representatives of these groups have been recorded from Dominican amber (Poinar & Poinar 1999).

## ACKNOWLEDGMENTS

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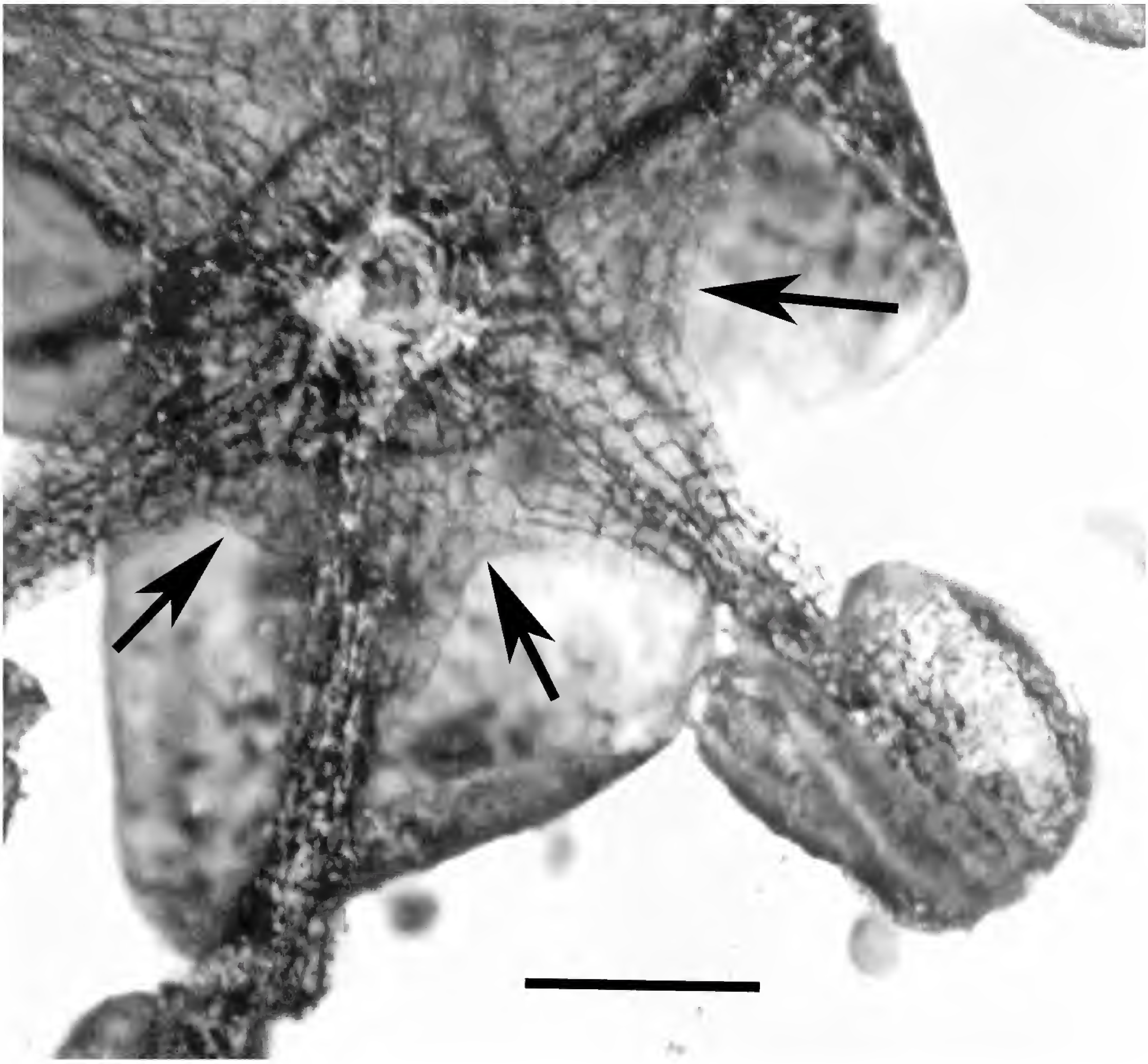

**Fig. 4.** ***Pseudhaplocricus hexandrus*. Apical view of flower showing tissue connections between filament bases of stamen whorl (arrows). Scale bar = 0.6 mm.**

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# BOOK NOTICE

Fructuoso Irigoyen-Rascón, with Alfonso Paredes. 2015. **Tarahumara Medicine: Ethnobotany and Healing among the Rarámuri of Mexico.** (ISBN-13: 978-0-8061-4828-1, hbk). University of Oklahoma Press, 2800 Venture Drive, Norman, Oklahoma 73069, U.S.A. (**Orders:** www.oupress.com, 1-800-627-7377). $49.95, 336 pp., 22 b&w illus., 3 maps, 4 tables, 6" × 9".

*From the Publisher:* The Tarahumara, one of North America's oldest surviving aboriginal groups, call themselves Rarámuri, meaning "nimble feet"—and though they live in relative isolation in Chihuahua, Mexico, their agility in long-distance running is famous worldwide. *Tarahumara Medicine* is the first in-depth look into the culture that sustains the "great runners." Having spent a decade in Tarahumara communities, initially as a medical student and eventually as a physician and cultural observer, author Fructuoso Irigoyen-Rascón is uniquely qualified as a guide to the Rarámuri's approach to medicine and healing.

In developing their healing practices, the Tarahumaras interlaced religious lore, magic, and careful observations of nature. Irigoyen-Rascón thoroughly situates readers in the Rarámuri's environment, describing not only their health and nutrition but also the mountains and rivers surrounding them and key aspects of their culture, from long-distance kick-ball races to corn beer celebrations and religious dances. He describes the Tarahumaras' curing ceremonies, including their ritual use of peyote, and provides a comprehensive description of Tarahumara traditional herbal remedies, including their botanical characteristics, attributed effects, and uses.

To show what these practices—and the underlying concepts of health and disease—might mean to the Rarámuri and to the observer, Irigoyen-Rascón explores his subject from both an outsider and an insider (indigenous) perspective. Through his balanced approach, Irigoyen-Rascón brings to light relationships between the Rarámuri healing system and conventional medicine, and adds significantly to our knowledge of indigenous American therapeutic practices.

As the most complete account of Tarahumara culture ever written, *Tarahumara Medicine* grants readers access to a world rarely seen—at once richly different from and inextricably connected with the ideas and practices of Western medicine.

**Fructuoso Irigoyen-Rascón** is a psychiatrist in McAllen, Texas. A former researcher at universities in Mexico and the United States, he has written extensively about Rarámuri ethnography and medical conditions.

**Alfonso Paredes** is Professor of Psychiatry at the University of California–Los Angeles and author of more than 100 medical papers, including several on the Tarahumara.

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# *COMOPELLIS PRESBYA* GEN. ET SP. NOV. (RHAMNACEAE) IN MID-TERTIARY AMBER FROM THE DOMINICAN REPUBLIC

Kenton L. Chambers
*Department of Botany & Plant Pathology*
*Oregon State University*
*Corvallis, Oregon U.S.A. 97331*
*chamberk@science.oregonstate.edu*

George O. Poinar, Jr.
*Department of Integrative Biology*
*Oregon State University*
*Corvallis, Oregon U.S.A. 97331*

## ABSTRACT

**Comopellis presbya** is described as a new genus and species of Rhamnaceae, based on a fossil flower preserved in amber from Mid-Tertiary deposits in the Dominican Republic. The fossil consists of a single pentamerous, bisexual flower at anthesis, characterized by narrowly lanceolate-elliptic petals with involute margins that partially cover the short, appressed stamen, together with a bowl-shaped hypanthium enclosing the sessile, superior pistil. The thin disc lining the hypanthium has 5 conspicuous appendages, 1 opposite the base of each sepal, which may have functioned as nectaries. The style is short, not surpassing the hypanthium, and bears a discoid, non-lobed stigma. With respect to its disc appendages, the genus is most similar to *Gouania* and *Distigouania* of the tribe Gouanieae (Medan & Schirarend 2004).

## RESUMEN

Se describe **Comopellis presbya** como Nuevo género y especie de Rhamnaceae, basados en una flor fósil preservada en ámbar de los depósitos del Terciario Medio en la República Dominicana. El fósil consiste en una flor simple pentámera y bisexual en antesis, que se caracteriza por los pétalos estrechamente lanceolado-elípticos con márgenes involutos que cubren parcialmente el estambre corto y apresado, junto con un hipanto en forma de taza que encierra el pistilo súpero sésil. El disco fino de revestimiento del hipanto tiene 5 apéndices conspicuos, opuestos a la base cada sépalo, que pudieran haber funcionado como nectarios. El estilo es corto, no sobrepasa el hipanto, y lleva un estigma discoide no lobulado. Con respecto a los apéndices del disco, el género es muy similar a *Gouania* y *Distigouania* de la tribu Gouanieae (Medan & Schirarend 2004).

## INTRODUCTION

Knowledge of the flora of tropical forests present in the Caribbean region in the Mid-Tertiary has improved through the recent description of fossil flowers preserved in amber from the Dominican Republic. Insects and plants of this forest were well treated by Poinar and Poinar (1999), based on fossils known at the time. Since then, some 23 new plant species, including a number of previously unknown genera, have been published. These include 3 species of Fabaceae (Poinar 1991; Dilcher et al. 1992; Poinar & Chambers 2015a), 2 of Poaceae (Poinar & Judziewicz 2005; Poinar & Columbus 2012), 3 of Arecaceae (Poinar 2002a, 2002b), 1 of Chrysobalanaceae (Poinar et al. 2008a, revised by Chambers & Poinar 2010), 2 of Lauraceae (Chambers et al. 2011a, 2012), 3 of Meliaceae (Chambers et al. 2011b; Chambers & Poinar 2012), 1 of Burseraceae (Chambers & Poinar 2013), 1 of Myristicaceae (Poinar & Steeves 2013), 1 of Rhamnaceae (Chambers & Poinar 2014a), 1 of Ticodendraceae (Chambers & Poinar 2014b), 1 of Commelinaceae (Poinar & Chambers 2015c), 1 possibly of Moraceae (Poinar et al. 2008b), and 1 of an unknown monocotyledonous family (Poinar & Chambers 2015b). A previously published fossil of Rhamnaceae from this flora, the genus *Distigouania*, is notable in being the first known member of the family with an irregular corolla and androecium (Chambers & Poinar 2014a).

## MATERIALS AND METHODS

*Comopellis* was collected from an amber mine in the northern mountain ranges (Cordillera Septentrional) of the Dominican Republic, between Puerto Plato and Santiago. Amber from mines in this region was produced by the leguminous tree *Hymenaea protera* (Poinar 1991). The age of the amber is controversial, with dates of 15–20 Ma and 30–45 having been proposed (Iturralde-Vinent & MacPhee 1996; Cépek in Schlee 1990). Both estimates are derived from microfossils in the marine strata containing the amber, the first authors deriving theirs from foraminifera and the latter author utilizing coccoliths. The amber is secondarily deposited in turbiditic sandstones of the Upper Eocene to Lower Miocene Mamey Group (Draper et al. 1964). According to

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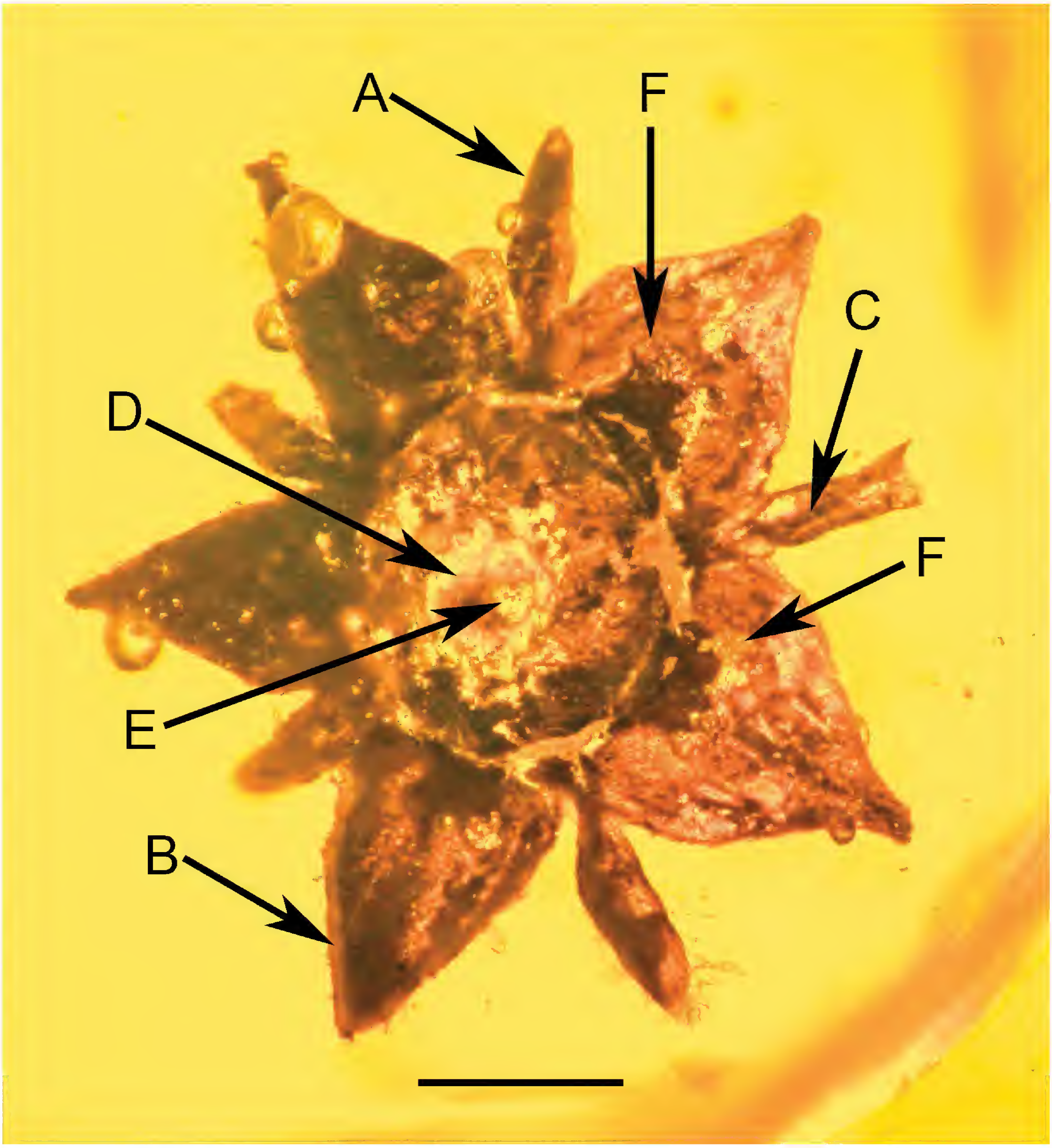

Fig. 1. *Comopellis presbya*. Apical view of flower. **A.** petal. **B.** sepal. **C.** stamen. **D.** ovary. **E.** stigma. **F.** disc appendages. Scale bar = 1.0 mm.

Dilcher et al. (1992), "… the amber clasts, from all physical characteristics, were already matured amber at the time of re-deposition into marine basins. Therefore the age of the amber is greater than Miocene and quite likely is as early as late Eocene." The discovery of Early Paleocene amber in Puerto Rico and Maastrichtian-Paleocene amber in Jamaica (Iturralde-Vinent 2001) adds to the known range of such deposits in the Greater Antilles.

Observations and photographs were made with a Nikon SMA-10 R stereoscopic microscope and Nikon Optiphot compound microscope with magnifications up to 600X. Helicon Focus Pro X54 was used to stack photos for better clarity and depth of field.

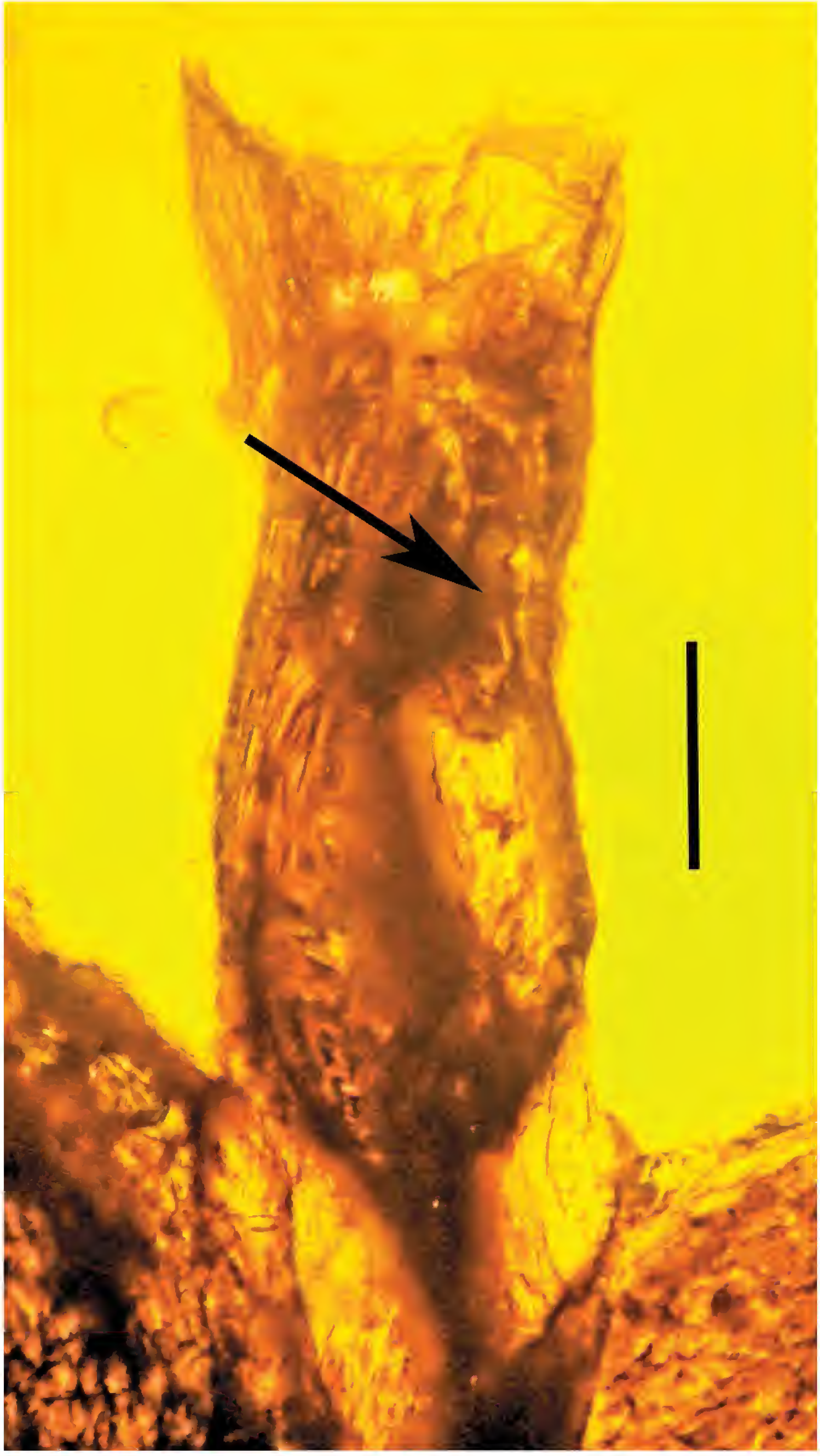

Fig. 2. *Comopellis presbya*. Petal enclosing stamen. Arrow indicates anther. Scale bar = 0.2 mm.

## DESCRIPTION

**Comopellis** K.L. Chambers & Poinar, gen. nov. (**Figs. 1–3**). Type Species: *Comopellis presbya* K.L. Chambers & Poinar sp. nov.

Flower bisexual, calyx regular, sepals 5, valvate, spreading, tip not thickened, midline not ridged (Fig. 1), corolla regular, petals 5, exceeded by sepals, margins involute, partially enclosing stamens, stamens appressed, ca. 0.75 times as long as petals (Fig. 2), anthers ca. 0.5 times as long as filaments, bilocular, introrsely dehiscent, pistil superior, basal in hypanthium, ovary globose, carpel number not determined, stigma broadly discoid, not lobed, included in hypanthium, hypanthium hemispherical, densely hispid abaxially (Fig. 4), disc

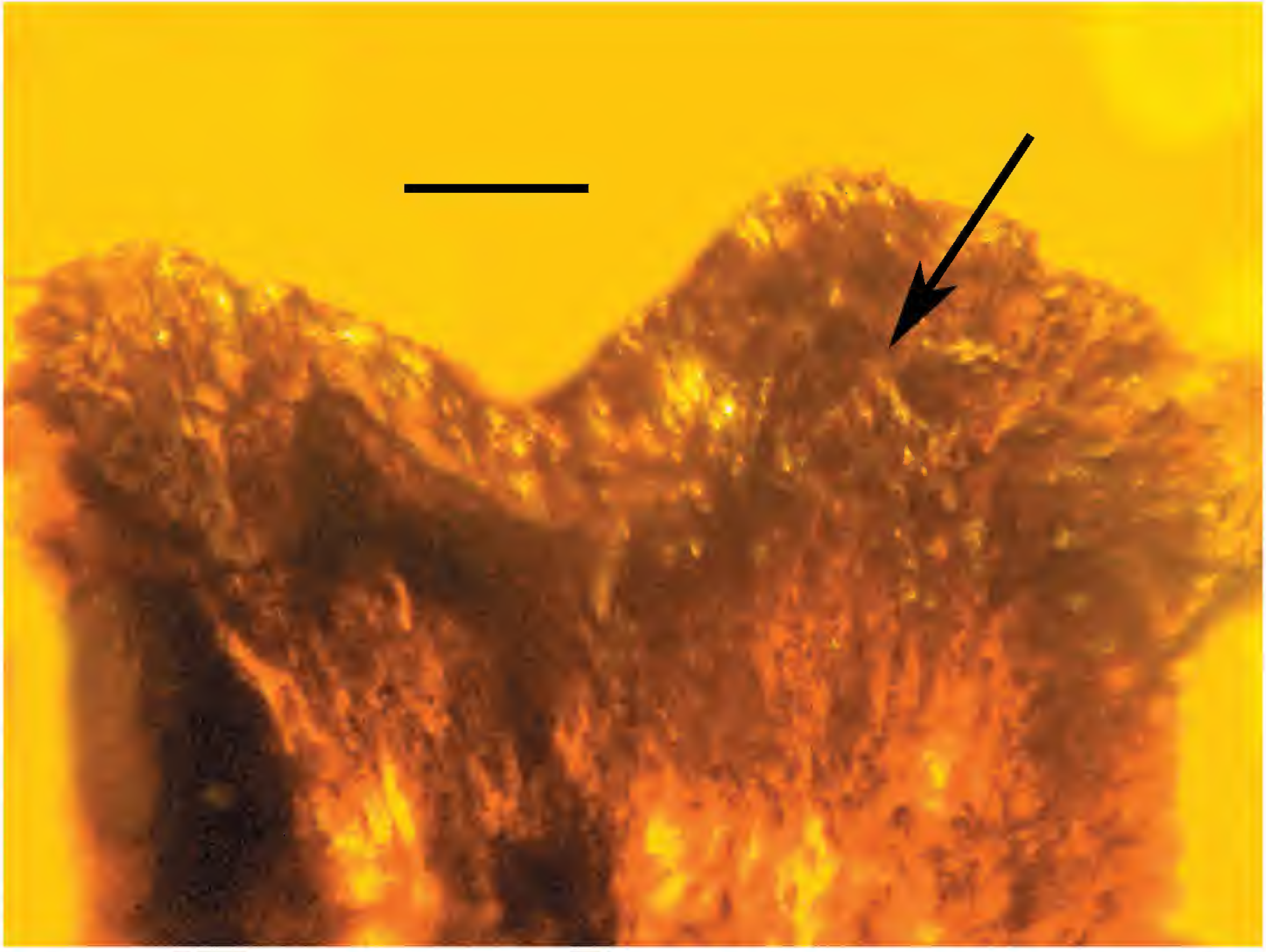

**Fig. 3.** ***Comopellis presbya*****. Apex of disc appendage. Arrow indicates glandular tissue. Scale bar = 0.1 mm.**

glabrous, thin, not fleshy, lining hypanthium, the margin forming a rim at base of perianth, with 5 bilobed appendages opposite sepals (Fig. 3), pedicel puberulent, ± equaling hypanthium (Fig. 4).

Etymology.—From Greek "kome," hair, and "pellis," cup or bowl, based on fossil's hirsute hemispheric hypanthium.

**Comopellis presbya** K.L. Chambers & Poinar, sp. nov. (**Figs. 1–4**). Type: HISPANIOLA. Dominican Republic: amber mine in the northern mountain ranges (Cordillera Septentrional, between Puerto Plato and Santiago), 2012, *unknown amber miner s.n.* (holotype: Catalog number Sd-9-194 , deposited in the Poinar amber collection maintained at Oregon State University, Corvallis, Oregon 97331, U.S.A.).

Width in apical view 4.6 mm, sepals broadly deltoid-ovate, 1.5–1.7 mm long, 0.9–1.4 mm wide, glabrous, apex acute, margins entire (Fig. 1), petals narrowly elliptic-lanceolate, 0.9–1.6 mm long, 0.2–0.4 mm wide, glabrous or lightly floccose apically, stamens 0.8–1.0 mm long, filaments ca. 0.7 mm long, anthers 0.2–0.3 mm long (Fig. 2), ovary 1.6 mm in diameter, style length not determined, stigma 0.7 mm wide (Fig. 1), hypanthium 1.7 mm wide, 0.8 mm high (Figs. 1, 4), appendages of disc ca. 0.8 mm long, glandular apically and possibly nectariferous (Fig. 3), pedicel 1.4 mm long.

*Etymology.*—From Greek "presbya," old, elder.

## DISCUSSION

Rhamnaceae are a family of ca. 57 genera and 950 species (Mabberley 2008). The tribal classification was revised by Richardson et al. (2000a) on the basis of morphological traits, and a phylogenetic analysis was presented (Richardson et al. 2000b) derived from plastid DNA sequences. Eleven tribes are recognized by these

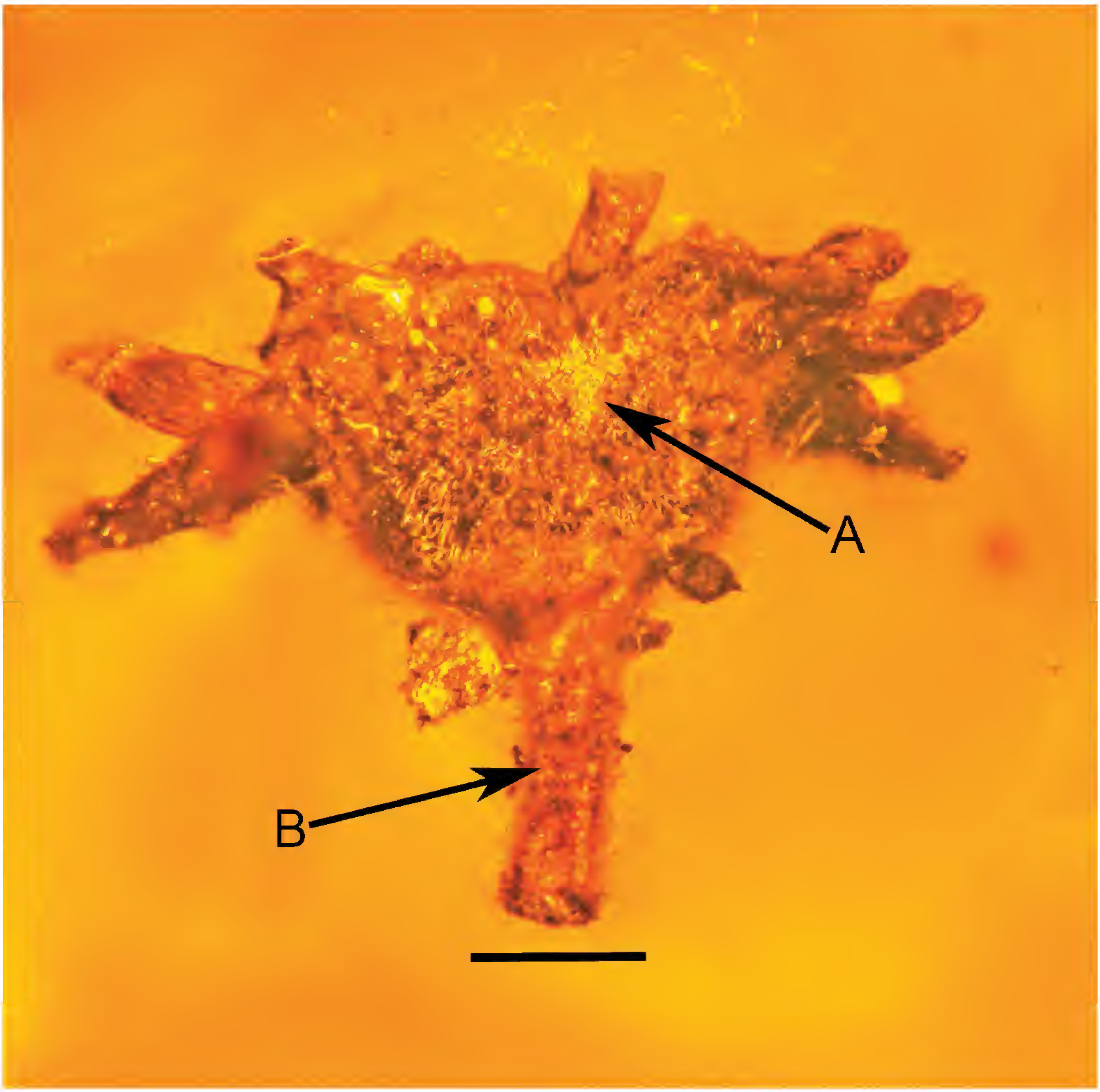

**Fig. 4.** ***Comopellis presbya*****. Lateral view of flower. A. hypanthium. B. pedicel. Scale bar = 0.8 mm.**

authors. A key to tribes and genera is given in Medan & Schirarend (2004), together with abbreviated tribal diagnoses. Vegetative and fruit characteristics, absent in the fossil, are important in the tribal classification; hence, we have not tried to assign *Comopellis* to a particular suprageneric category. Distinctive features that might help in tribal placement of the fossil are the lack of a keeled midrib on the sepals, lanceolate petals laterally enfolding the appressed stamens, the hemispherical hypanthium, the bilobed, gland-tipped appendages of the hypanthial disc, and the discoid, unlobed stigma. The disc appendages of *Distigouania* are similarly gland-tipped, but its flowers are unisexual and irregular, with anthers free from the petals, disc filling the hypanthium, and petals ovate-deltoid and sepaloid in texture (Chambers & Poinar 2014a). The related genus *Gouania* has a fleshy disc and inferior ovary. Flowers of *Nahinda*, an Oligocene fossil from Puebla, Mexico (Calvillo-Canadell & Cevallos-Ferriz 2007), differ from *Comopellis* in lacking disc appendages and possessing a thickened midline rib and apex on the sepals. Based on a comparison of its features with published illustrations and descriptions (Suessenguth 1953; Liogier 1981; Medan & Schirarend 2004), with a focus on extant genera of

Rhamnaceae from the Caribbean and the New World in general, we have not been able to find a placement for the fossil, which is here described as new to science.

## ACKNOWLEDGMENTS

We thank Melanie DeVore, Melissa Islam, and Steven Manchester for their helpful review comments.

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# BOOK NOTICE

T. Scott Bryan & Betty Tucker-Bryan. 2015. **The Explorer's Guide to Death Valley National Park, 3rd ed.** (ISBN-13: 978-1-60732-340-2, pbk). University Press of Colorado, 5589 Arapahoe Avenue, Suite 206C, Boulder, Colorado 80303, U.S.A. (**Orders:** www.upcolorado.com, 1-800-621-2736). $23.95, 472 pp., 152 illus., 6" × 9".

*From the Publisher:* Originally published in 1995, soon after Death Valley National Park became the fifty-third park in the US park system, *The Explorer's Guide to Death Valley National Park* was the first complete guidebook available for this spectacular area.

Now in its third edition, this is still the only book that includes all aspects of the park. Much more than just a guidebook, it covers the park's cultural history, botany and zoology, hiking and biking opportunities, and more. Information is provided for all of Death Valley's visitors, from first-time travelers just learning about the area to those who are returning for in-depth explorations.

The book includes updated point-to-point logs for every road within and around the park, as well as more accurate maps than those in any other publication. With extensive input from National Park Service resource management, law enforcement, and interpretive personnel, as well as a thorough bibliography for suggested reading, *The Explorer's Guide to Death Valley National Park, Third Edition* is the most up-to-date, accurate, and comprehensive guide available for this national treasure.

**T. Scott Bryan** was a seasonal employee at Yellowstone National Park from 1970 through 1986. In addition to his studies in Yellowstone, he has been to geyser fields throughout the contiguous United States, Mexico, Japan, Fiji, New Zealand, and the Valley of Geysers on the Kamchatka Peninsula of Russia, leading the first-ever US study group there in 1991.

**Betty Tucker-Bryan** is the founder of the Death Valley Hikers Association and has written numerous books and articles on the outdoors.

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# *KLAPROTHIOPSIS DYSCRITA* GEN. ET SP. NOV. (LOASACEAE) IN MID-TERTIARY DOMINICAN AMBER

George O. Poinar, Jr.

*Department of Integrative Biology*
*Oregon State University*
*Corvallis, Oregon 97331, U.S.A.*
*poinarg@science.oregonstate.edu*

Maximilian Weigend

*Nees-Institut für Biodiversität der Pflanzen*
*Rheinische-Friedrich-Wilhelms Universität Bonn*
*Meckenheimer Allee, 170 53115 Bonn, GERMANY*

Tilo Henning

*Botanischer Garten und Botanisches Museum*
*Freie Universität Berlin*
*Königin-Luise Str. 6-8, 14195 Berlin, GERMANY*

## ABSTRACT

**Klaprothiopsis dyscrita** gen. et sp. nov. is described from two flowers in Dominican Republic amber. The actinomorphic, tetramerous, bisexual flowers are synsepalous with a short calyx tube and four imbricate persistent lobes rounded at their apices. The four delicate, membranous petals are inserted at the throat of the calyx. A pair of curved ciliolate staminodes is situated opposite each petal. In addition, the androecium consists of eight stamens with long, filiform filaments bearing introse anthers with lateral dehiscence. The inferior ovary is crowned by a minute filiform style with a slightly thickened stigma. The fossils show strong affinities with the tribe Klaprothieae based on similarity in flower structure but are only tentatively assigned to that group due to some conflicting morphological characters, especially the antepetalous staminode insertion (vs. antesepalous in extant representatives). These flowers add to the floral diversity of plant communities that existed in the West Indies in the mid-Tertiary.

Key Words: *Klaprothiopsis dyscrita* gen. et sp. nov. Loasaceae, Klaprothieae, Dominican amber, paleobotany

## RESUMEN

**Klaprothiopsis dyscrita** gen. et sp. nov. es descrita en base a dos flores preservadas en ámbar provenientes de la República Dominicana. Las flores son actinomorfas, tetrámeras, bisexuales, sinsépalas con el cáliz formando un tubo corto y cuatro lóbulos imbricados, persistentes con ápices redondeados. Los cuatro pétalos delicados y membranáceos se encuentran insertados en el ápice del tubo calicino. Los dos estaminodios curvados, ciliolados están opuestos a los pétalos. El androceo consiste en ocho estambres con filamentos largos, filiformes, con anteras introrsas de dehiscencia lateral. El ovario ínfero termina en un estilo pequeñísimo con un estigma un poco ensanchado. Los fósiles son muy parecidos a los de la tribu Klaprothieae en su estructura floral, pero muestran algunas características algo aberrantes para el grupo, especialmente la inserción antepétala de los estaminodios (en contraste con una inserción antesépala en los representantes actuales). Estas flores representan una importante contribución a nuestro conocimiento de la diversidad floral de las comunidades vegetales que existían en las islas de las Indias Occidentales durante la Era del Terciario Medio.

## INTRODUCTION

Fossil flowers in amber from the Dominican Republic have provided rare records of Neotropical plant families and genera that existed in Hispaniola during the mid-Tertiary. Thus far representatives of the families Fabaceae, Arecaceae, Poaceae, Chrysobalanaceae, Lauraceae, Meliaceae, Burseraceae, Myristicaceae, Rhamnaceae and Ticodendraceae have been described from Dominican amber (references listed in Poinar & Chambers 2014). The present study reports the first putative fossil representatives of the family Loasaceae (Cornales). The Loasaceae is a relatively small family comprising some 350 species in 20 genera of tropical and subtropical herbs, shrubs, trees and lianas, mainly occurring in the Americas (Weigend 2004a, b) with the exception of two genera.

## MATERIALS AND METHODS

The fossils originated from amber mines in the northern mountain range (Cordillera Septentrional) of the Dominican Republic between Puerto Plata and Santiago. Amber from mines in this region was produced by *Hymenaea protera* Poinar (1991) (Fabaceae).

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The Dominican amber forest was characterized by Poinar and Poinar (1999) based on both animal and plant fossils.

Dating of Dominican amber is controversial, with the youngest proposed age of 20–15 mya based on Foraminifera (Iturralde-Vinent & MacPhee 1996) and the oldest of 45–30 mya based on coccoliths (Cêpek in Schlee 1990). These are considered minimum dates as they are based on microfossils in the strata containing the amber. Most of the amber was secondarily deposited in turbiditic sandstones of the Upper Eocene to Lower Miocene Mamey Group (Draper et al. 1994). Dilcher et al. (1992) stated that "… the amber clasts, from all physical characteristics, were already matured amber at the time of re-deposition into marine basins. Therefore, the age of the amber is greater than Miocene and quite likely is as early as late Eocene". The issue is further complicated by the discovery of Early Oligocene amber in Puerto Rico and Maastrichtian-Paleocene amber in Jamaica (Iturralde-Vinent 2001) showing that amber from a range of deposits occurs in the Greater Antilles.

Observations and photographs were made with a Nikon SMZ-10 R stereoscopic microscope and Nikon Optiphot compound microscope with magnifications up to 600 X. Helicon Focus Pro X64 was used to stack photos for better clarity and depth of field.

The two fossil flowers are in separate pieces of Dominican amber. The specimens differ slightly in size and tint but share the same morphological features and are considered to belong to the same species.

## DESCRIPTION

Loasaceae Jusseau 1804

**Klaprothiopsis** Poinar, Weigend, & Henning, gen. nov. (**Figs. 1–7**). Type Species: *Klaprothiopsis dyscrita* Poinar, Weigend, & Henning, sp. nov.

**Klaprothiopsis dyscrita** Poinar, Weigend, & Henning, sp. nov. (**Figs. 1–7**). Type: HISPANIOLA. Dominican Republic: amber mine in the northern mountain ranges (Cordillera Septentrional), 1986, *unknown amber miner s.n.* (holotype: accession # Sd-9-108A and paratype (accession # Sd-9-108B) deposited in the Poinar amber collection maintained at Oregon State University, Corvallis, Oregon 97331, U.S.A.).

*Holotype Sd-9-108A* (Figs. 1–5): Actinomorphic, tetramerous, bisexual flower, pedicellate; pedicel 2.2 mm long, set with simple trichomes; ovary inferior; calyx tube wide, calyx lobes persistent, ovate, 1.1 mm long, apex obtuse, 0.7 mm wide; petals half spreading, narrowly ovate, delicate, membranous, 2.6–2.8 mm long, 1.1 mm wide, set with simple trichomes at base and margin, base slightly narrowed, apex acuminate, entire; staminodia antepetalous, 2 per petal, curved, ciliolate, 0.6–0.8 mm long, densely set with simple trichomes; stamens 8, 3.0–3.5 mm long, filaments filiform, anthers introse, 0.4–0.6 mm long, 0.2–0.3 mm wide, with lateral dehiscence; style filiform, 0.2 mm long, stigma slightly thickened.

*Paratype Sd-9-108B* (Figs. 6,7): Actinomorphic, tetramerous, bisexual flower, pedicellate; pedicel 3.0 mm long, set with simple trichomes; ovary inferior; calyx tube wide, calyx lobes persistent, ovate, 1.2 mm long, apex obtuse, 0.7 mm wide; petals half spreading, narrowly ovate, delicate, membranous, 2.5 mm long, 1.1 mm wide, set with simple trichomes at base and margin, base slightly narrowed, apex acuminate, entire; staminodia antepetalous, 2 per petal, curved, ciliolate, 0.6–0.8 mm long, densely set with simple trichomes; stamens 8, 2.9 mm long, filaments filiform, anthers introse, 0.5 mm long, 0.2 mm wide, with lateral dehiscence; style filiform, 0.2 mm long, stigma slightly thickened.

*Etymology.*—The generic name reflects the similarity of the fossil to the genus *Klaprothia* (see Fig. 8). The specific epithet is from the Greek "*dyskrita*" = difficult to determine.

## DISCUSSION

*Klaprothiopsis dyscrita* gen. et sp. nov. is provisionally assigned to the Loasaceae and shows strong similarities to the tribe Klaprothieae based on its flower morphology. A range of characters, such as flower size, tetramerous perianth, shape and persistence of the sepals, membranous petal structure and the peculiar free, club-shaped, papillose staminodes support this placement. This group also has protandrous flowers with a style that elongates only late in anthesis, indicating that the two fossil flowers may be early anthetic, therefore

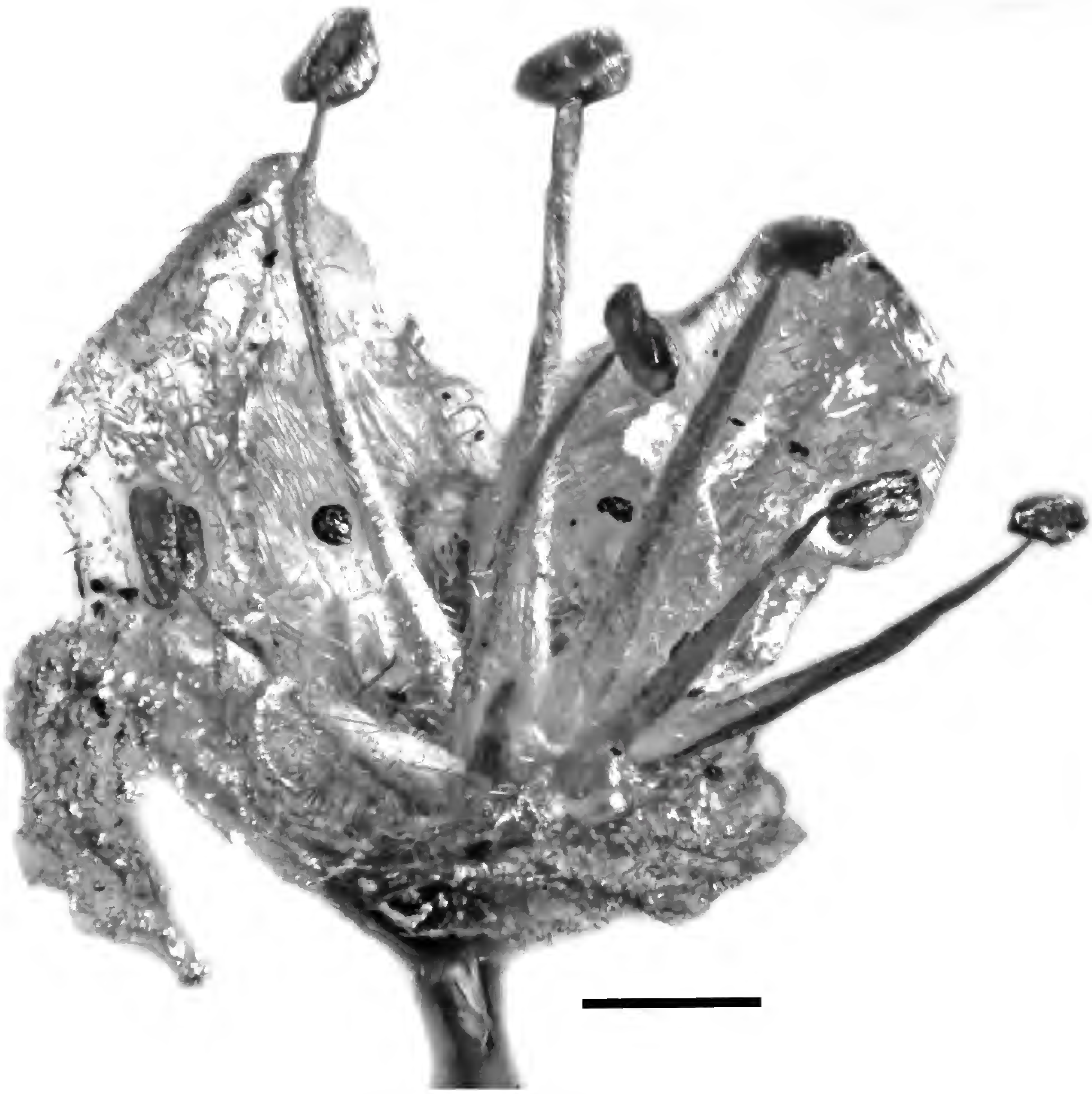

**Fig. 1. Lateral view of side A of *Klaprothiopsis dyscrita* gen. et sp. nov. Holotype Sd-9-108A in Dominican amber. Scale bar = 0.8 mm.**

having only a very short style. Thus, detailed floral morphology and geographic distribution support Klaprothia spp. as closest relatives of *Klaprothiopsis dyscrita* gen. et sp. nov. (Table 1).

Table 1. Comparison of *Klaprothiopsis dyscrita* gen. et sp. nov. with the two extant species in the genus *Klaprothia*. All measurements are in millimeters.

| | *Klaprothia mentzelioides* | *Klaprothia fasciculata* | *Klaprothiopsis dyscrita* gen. et sp. nov. |
|---|---|---|---|
| Length petioles | 5–60 | 10–38 | 2.2–3 |
| Length sepals | 1.0–2.2 | 0.75–2 | 1.1–1.2 |
| Length petals | 2.0–5.7 | 1.0–1.75 | 2.5–2.8 |
| No. of stamens | 16–20 | 4–12 | 8 |
| Length of stamens | 2.5–4.0 | 0.75–1.0 | 2.9–3.5 |
| No. of staminodes | 5, three outer and 2 free inner | 2*–3, free | 2, free |
| Length of staminodes | 1.5–3.0 | 0.5–0.75 | 0.6–0.8 |
| Position of staminodes | antesepalous | antesepalous | antepetalous |
| Style length | 2.0–3.0 | 0.5–1.25 | 0.2 |
| Shape of ovary | obovoid to oblong, short | cylindrical to obovoid, elongated | minute |

* Poston & Nowicke (1990): 2–3 written in the key, 3 in the diagnoses

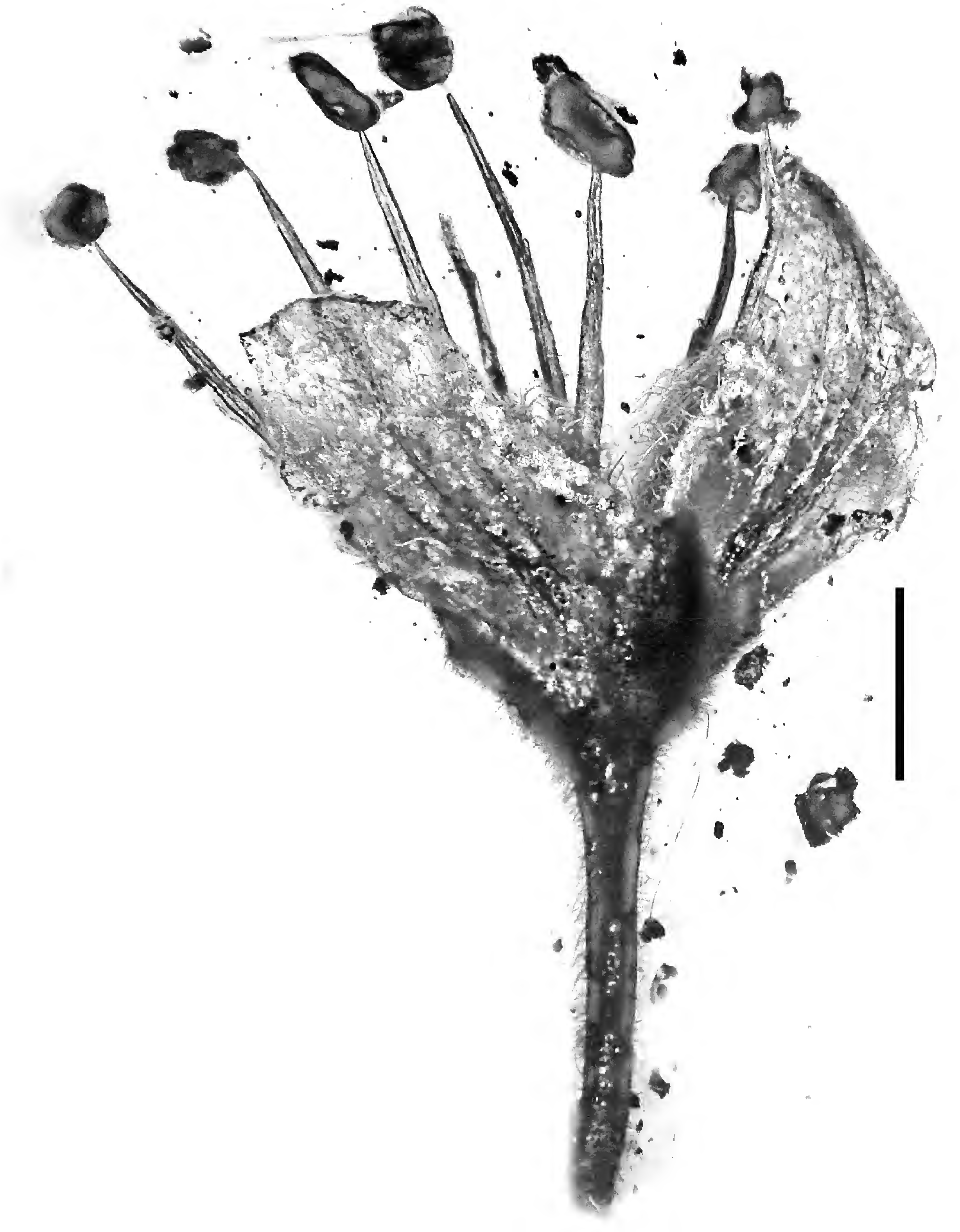

Fig. 2. Lateral view of side B of *Klaprothiopsis dyscrita* gen. et sp. nov. Holotype Sd-9-108A with pedicel and calyx in Dominican amber. Scale bar = 1.4 mm.

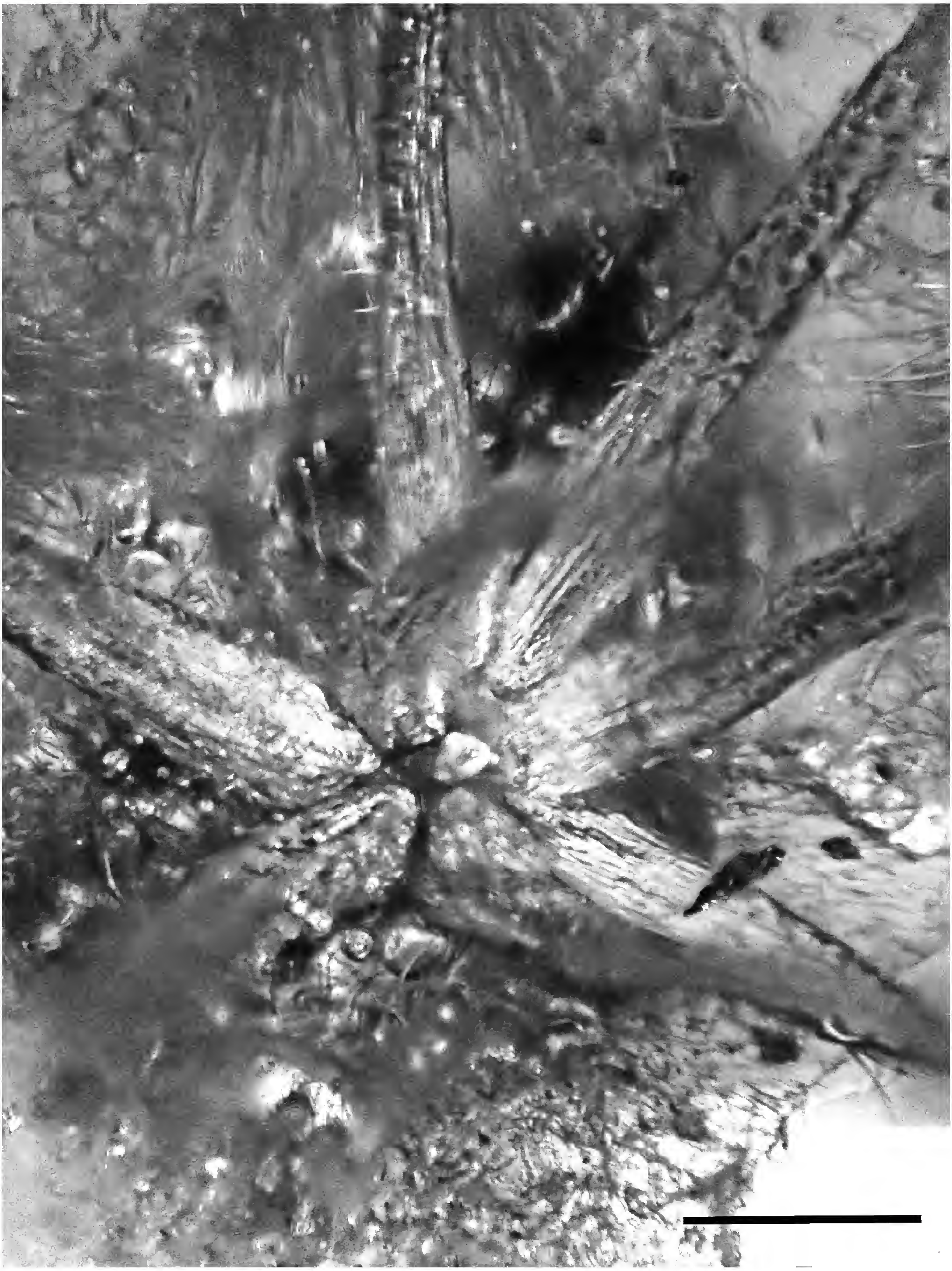

Fig. 3. Top view of center of *Klaprothiopsis dyscrita* gen. et sp. nov. Holotype Sd-9-108A in Dominican amber. Scale bar = 0.5 mm. Note short pistil surrounded by stamen bases.

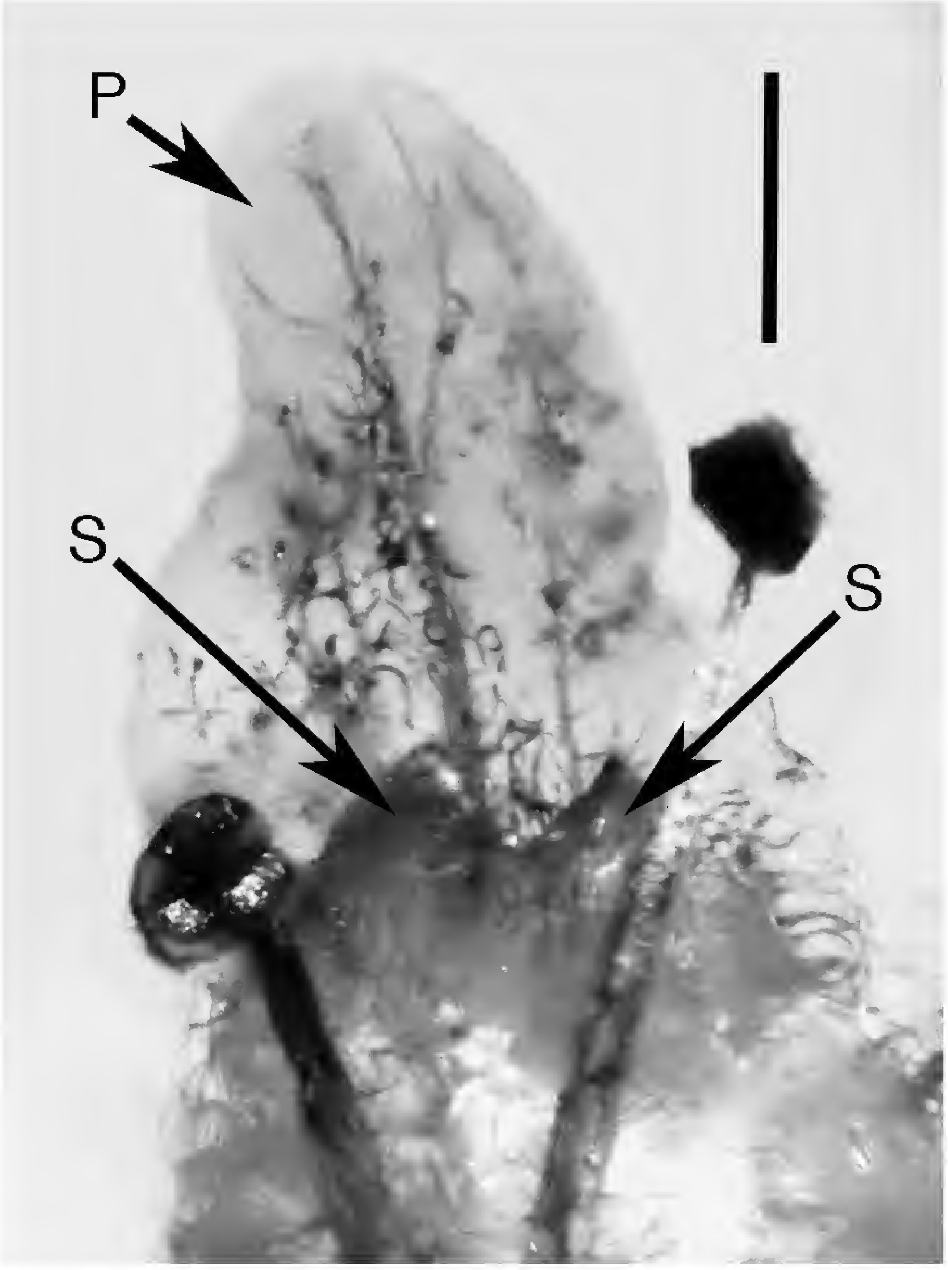

**Fig. 4. Inside view of *Klaprothiopsis dyscrita* gen. et sp. nov. Holotype Sd-9-108A showing paired staminodes (S) in front of a petal (P) in Dominican amber. Scale bar = 0.5 mm.**

However, there are some striking morphological differences between the fossil and extant *Klaprothia*—and indeed all Loasoideae. Most notable is the antepetalous insertion of the staminodes since both staminodes and staminodial complexes are universally found in an antesepalous position in extant Loasoideae. Another character is the receptacle and the ovary. Throughout Loasaceae and indeed all Cornales, the inferior ovary develops proleptically, i.e., is already largely developed before anthesis begins. Thus, the inferior and the corresponding smaller superior part of the ovary are usually well visible at beginning of the anthesis. The fossil has a very small ovary and a minuscule style that could be interpreted as a rudimentary female organ in an otherwise male flower. This would indicate a monoecious or dioecious species, which would argue against Loasaceae with exclusively hermaphroditic flowers. Finally, although members of the Loasaceae literally exhibit almost all trichome types known in the plant kingdom, smooth trichomes as found in the fossil flowers are extremely rare in extant species and not known from Klaprothieae (Poston & Nowicke 1990, 1993; Dostert & Weigend 1999; Weigend 1997a, 2004; Noguera-Savelli et al. 2009). These similarities and differences are difficult to evaluate, especially in the light of the age of Dominican amber.

In conclusion, the present placement of *Klaprothiopsis dyscrita* gen. et sp. nov. cannot be confirmed with absolute certainty due to the above mentioned conflicting characters that question our preliminary assignment. Overall, the characters observed either support or question placement in Loasaceae, but none of them, whether observed (smooth trichomes) or assumed (e.g. monoecy vs. proterandry) strongly indicate an alterna-

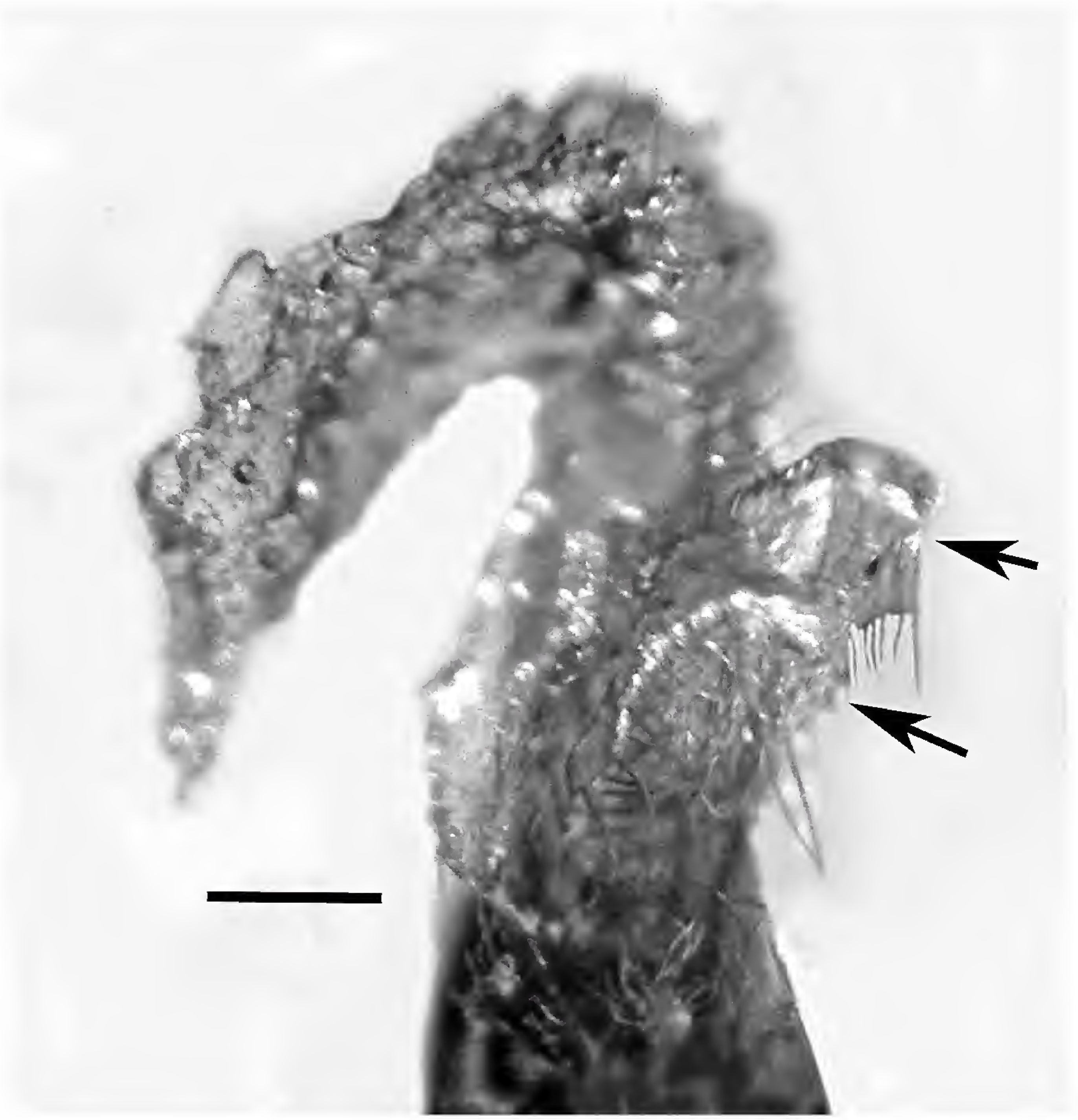

**Fig. 5. Lateral view of paired staminodes (arrows) of *Klaprothiopsis dyscrita* gen. et sp. nov. Holotype Sd-9-108A in Dominican amber. Scale bar = 0.3 mm.**

tive assignment to any other extant plant family we know. Thus for the present, we treat the fossil as allied to the Klaprothieae, but refer to it as *Klaprothiopsis dyscrita* gen. et sp. nov., which reflects our uncertainty of its placement.

Klaprothieae have repeatedly been retrieved as monophyletic by both, morphological (Weigend 1997a, b, 2004) and molecular data (Hufford et al. 2003, 2005; Weigend et al. 2004) and represent one of the basal clades of Loasaceae subfam. Loasoideae. In so-called "Higher Loasoideae" the staminodes are united into staminodial complexes, some of them fused into floral scales. Klaprothieae comprise three small genera (*Klaprothia* Kunth.—2 spp, *Plakothira Florence* (1997)—3 spp and *Xylopodia klaprothioides* Weigend—monotypic), with a heterogenous distribution. The two species of *Klaprothia* (*K. mentzelioides* Kunth. and *K. fasciculata* (C. Presl) Poston, Poston & Nowicke 1990) are widespread in Central and Western South America (up to Mexico), Brazil, Caribbean Islands and Galapagos Islands, whereas *Plakothira* spp. are restricted to the Marquesas Islands (Polynesia) and *Xylopodia* is microendemic from the area around Contumazá in northern Peru (Weigend 1997a, Weigend et al. 2006). In flower size and details of the staminodes, both *Xylopodia* and *Plakothira* differ clearly from the fossil flowers, which are essentially intermediate between the two extant spe-

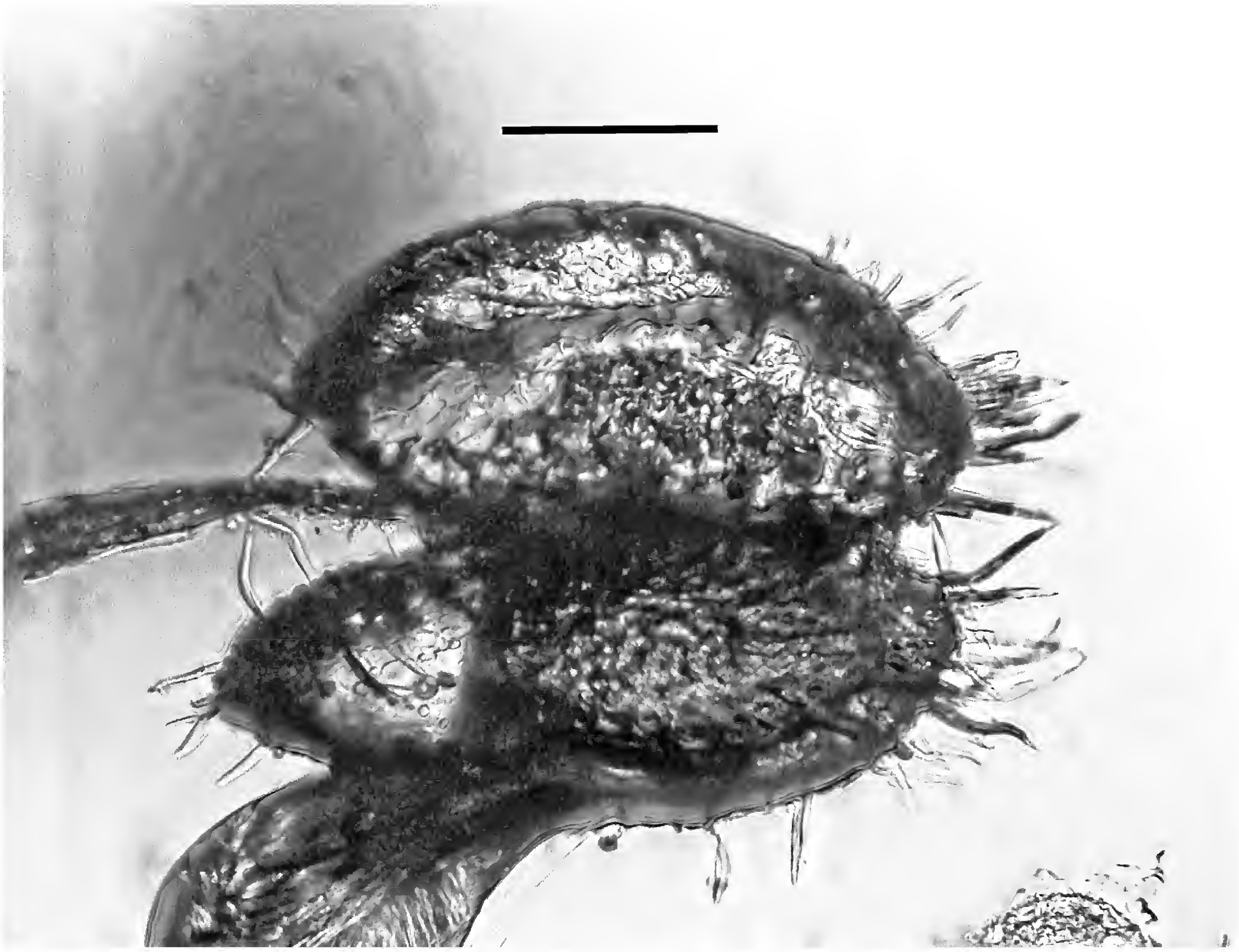

**Fig. 6. Dehisced anther of *Klaprothiopsis dyscrita* gen. et sp. nov. Paratype (Sd-9-108B) in Dominican amber. Scale bar = 0.2 mm.**

cies of *Klaprothia*. Apart from the substantial differences discussed above, *Klaprothiopsis dyscrita* gen. et sp. nov. most closely resembles *K. fasciculata* in terms of the remaining flower morphological characters. This is also the most plausible placement based on the fossil's distribution: *K. fasciculata* is represented in the Caribbean by two specimens collected in Haiti at low and intermediate elevations (150–1600 m), whereas *K. mentzelioides* is montane (1000–3500 m, Poston & Nowicke 1990). Dated phylogenies provide an estimated age of 44–94 Ma (Xiang et al. 2011) and ca. 60–92 respectively (Schenk & Hufford 2010) for the crown group of Loasaceae. Schenk & Hufford (2010) also provide an estimated age for subfam. Loasoideae of c. 65 Ma with the Klaprothieae splitting from the stem lineage between 25–55 Ma ago. *Klaprothia fasciculata* is tentatively dated at only ca. 5–10 Ma in their analyses. The age of *Klaprothiopsis dyscrita*, e.g., ranging between 20–15 (Iturralde-Vincent & MacPhee 1996) and 45–30 (Cêpek in Schlee 1990) Ma, is incompatible with the potentially young age of its possible closest extant relative *K. fasciculata* (based on this rather broad study on order-level). Nevertheless, the characters detailed above, including the combination of features found in both extant species of *Klaprothia* (Table 1) and the potentially great age of lineages in the Klaprothieae (Schenk & Hufford 2010) justify the assignment of the fossils in the proximity of the Klaprothieae.

An analysis of plant and animal inclusions in Dominican amber showed that the amber forest was a tropical moist forest (Poinar & Poinar 1999). Such forests today, which occur throughout the Neotropics, commonly have a dry season of 3 or 4 months, followed by a wet period of 8 to 9 months. The amber forest probably had several layers of vegetation including canopy, subcanopy, understory, shrub and forest floor strata, which is typical of moist forests today. Vines and epiphytes would have extended from tree to tree. Such forests no longer exist in Hispaniola.

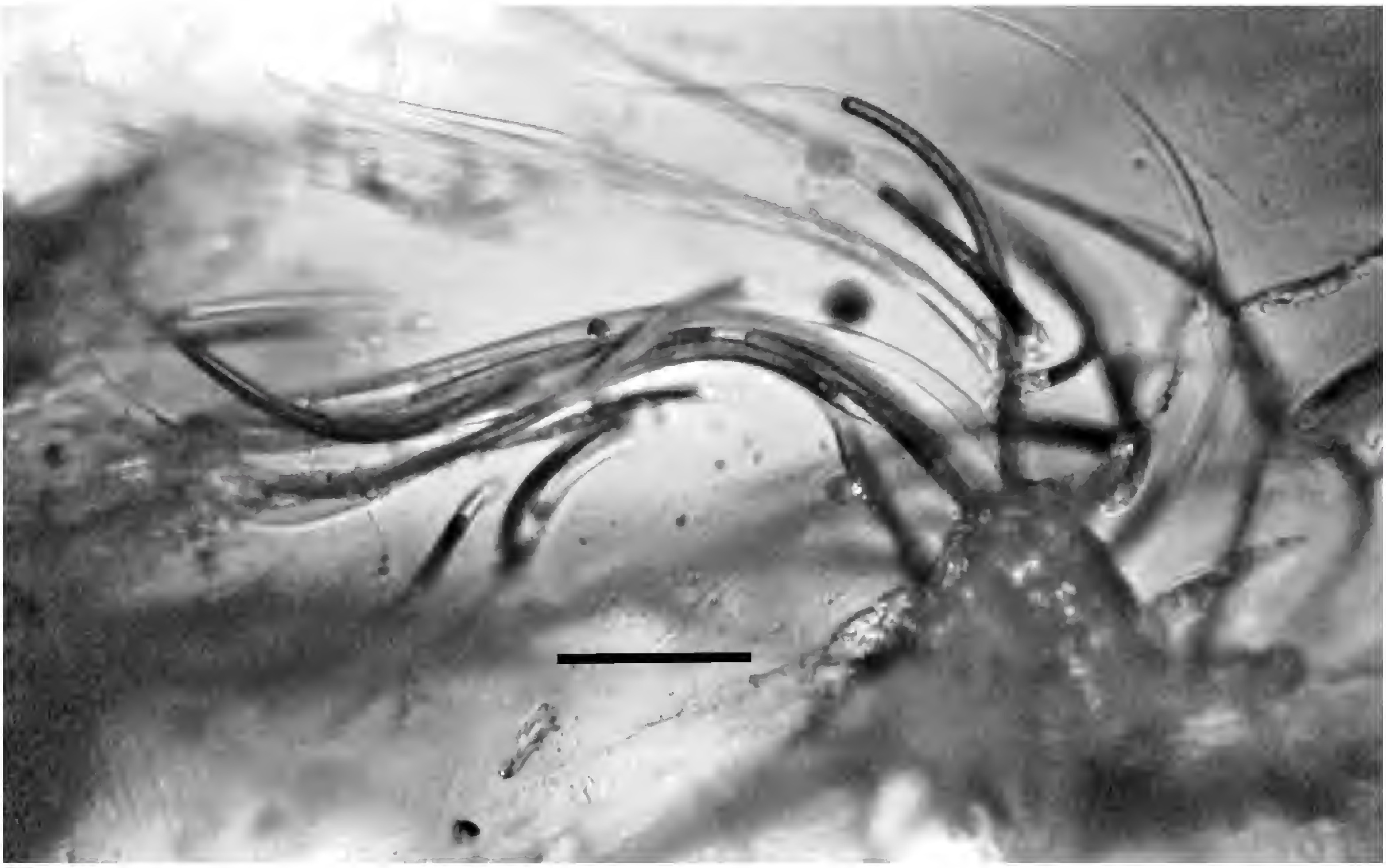

Fig. 7. Smooth trichomes on surface of petal of *Klaprothiopsis dyscrita* gen. et sp. nov. Paratype (Sd-9-108B) in Dominican amber. Scale bar = 0.15 mm.

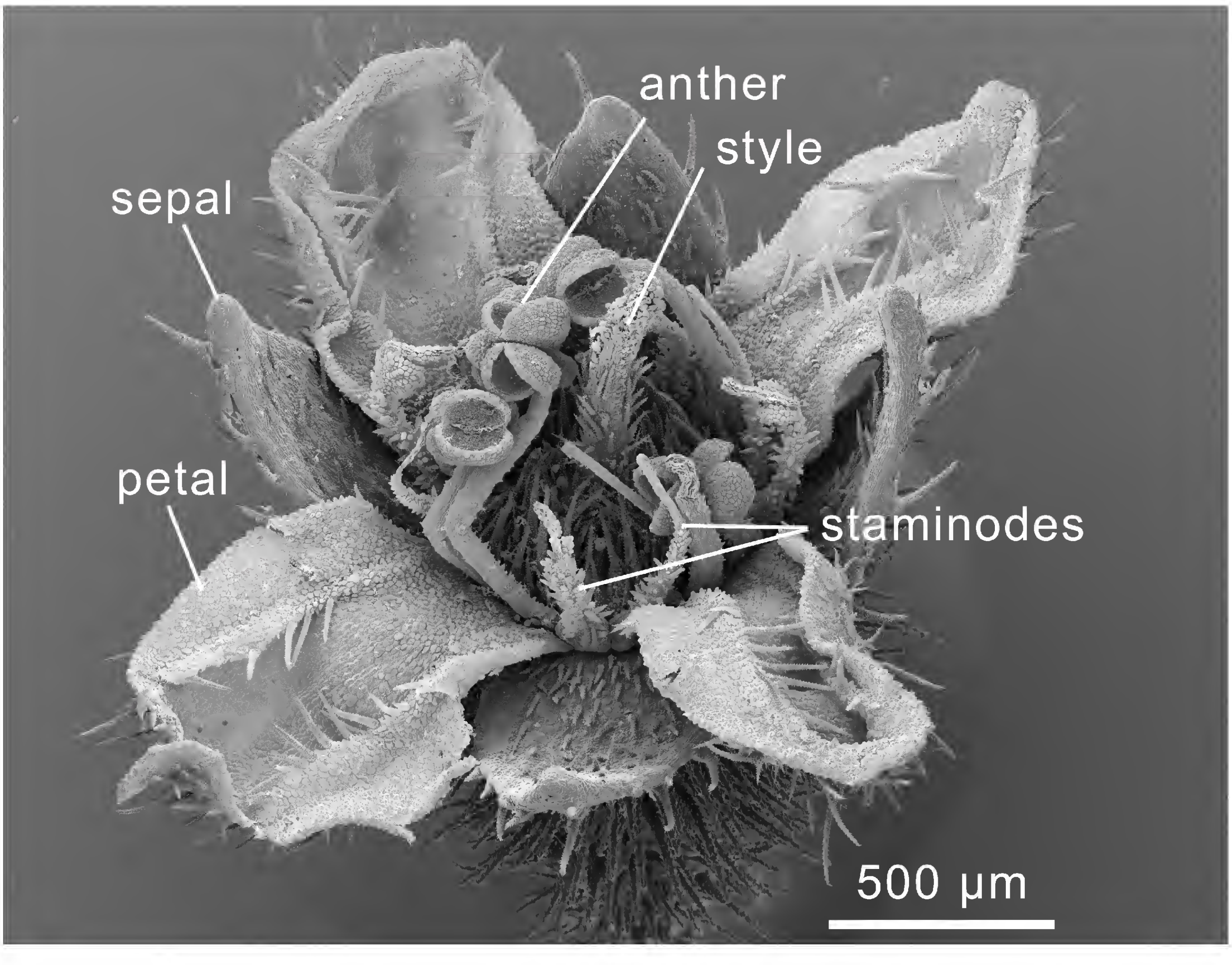

Fig. 8. SEM-photo of top view of the extant *Klaprothia fasciculata*. Voucher: Peru, Dept. Amazonas, Prov. Bagua. La Peca, trail to El Paraiso, 1000–1300 m, adjacent to banana plantations and along riverbanks. 30.03.1998. Nicolas Dostert 98/76 (M).

*Klaprothiopsis dyscrita* gen. et sp. nov. probably had a herbaceous habit, similar to that of the two extant species of Klaprothia. Their presence in amber suggests that *Klaprothiopsis dyscrita* gen. et sp. nov. either grew closely adjacent to or climbed the trunks of the resin producing trees that produced the amber. These amber flowers add to the floral diversity that was present in the West Indies in the mid-Tertiary.

## ACKNOWLEDGMENTS

Thanks are extended to Hans-Jürgen Ensikat (Bonn) for preparing the SEM-picture of extant *K. fasciculata* and to two reviewers whose remarks enhanced the paper.

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# BOOK NOTICE

Ghillean T. Prance. 2014. **That Glorious Forest: Exploring the Plants and Their Indigenous Uses in Amazonia.** (ISBN-13: 978-0-893-27528-0, hbk). New York Botanical Garden Press, Library Bldg, Room M221, 2900 Southern Boulevard, Bronx, New York 10458-5126, U.S.A. (**Orders:** www.nybgpress.org, 1-718-817-8721). $69.00, 224 pp., 8.5" × 10".

*From the Publisher:* After nearly fifty years since his first journey to the tropics exploring for plants, and a total of thirty-nine expeditions to the Amazon, Professor Sir Ghillean Prance has gathered in this volume a fascinating and diverse collection of accounts from these experiences, along with his thoughts on a lifetime of work surveying the Amazon flora. A prominent botanist and ecologist, as well as the former Senior Vice President of Science at The New York Botanical Garden, and subsequently Director of the Royal Botanic Gardens, Kew (1988-1999), Sir Ghillean has written this book as a tribute to the many people who have helped him to survey the Amazon region over the last five decades. The main focus in this volume is placed on the process and the running of the expeditions, as well as collecting specimens. Included at the end of each chapter are plant collection numbers made on the expeditions described, as well as a list of new species discovered. Professor Prance is a specialist in a number of plant families, all of which consist of trees and vines widely distributed in the Amazon region and elsewhere. In recognition of more than a quarter century of his service and ongoing extraordinary dedication to the mission of The New York Botanical Garden, and to botany and horticulture internationally, Sir Ghillean was presented in 2008 with the Gold Medal of The New York Botanical Garden, where he served as a scientist and senior scientific administrator. This medal is the highest honor that the Botanical Garden confers. In the botanical exploration of Amazonian Brazil, there is probably no contemporary name more prominent than that of Sir Ghillean Prance.

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# ADDENDUM: *PRIORIA DOMINICANA* SP. NOV. (FABACEAE: CAESALPINIOIDEAE), A FOSSIL FLOWER IN MID-TERTIARY DOMINICAN AMBER

George O. Poinar, Jr.

*Department of Integrative Biology*
*Oregon State University*
*Corvallis, Oregon 97331, U.S.A.*
*poinarg@science.oregonstate.edu*

Kenton L. Chambers

*Department of Botany and Plant Pathology*
*Oregon State University*
*Corvallis, Oregon 97331, U.S.A.*

In the original publication, the dimensions of the scale bars in the 3 figures were inadvertently omitted. The correct values are as follows:

Fig. 1. Scale bar = 1.1 mm

Fig. 2. Scale bar = 0.9 mm

Fig. 3. Scale bar = 0.6 mm

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# JOURNAL NOTICE

Neal K. Van Alfen, Jan E. Leach, and Steven Lindlow, eds. 2015 (Aug). **Annual Review of Phytopathology, Volume 53.** (ISSN: 0066-4286; ISBN: 978-0-8243-1353-1, hbk). Annual Reviews, Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303, U.S.A. (**Orders:** www.AnnualReviews.org, science@annualreviews.org, 1-800-523-8635, 1-650-493-4400). $99.00 indiv., 634 pp., 7.5" × 9.25".

ABOUT THIS JOURNAL—The *Annual Review of Phytopathology,* in publication since 1963, covers the significant developments in the field of plant pathology, including plant disease diagnosis, pathogens, host-pathogen Interactions, epidemiology and ecology, breeding for resistance and plant disease management, and includes a special section on the development of concepts.

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1. The Wayward Hawaiian Boy Returns Home—*D. Gonsalves*
2. Playing on a Pathogen's Weakness: Using Evolution to Guide Sustainable Plant Disease Control Strategies—*J. Zhan, P.H. Thrall, J. Papaïx, L. Xie, & J.J. Burdon*
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**Errata**

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# BREEDING SYSTEM AND SEX RATIO VARIATION IN MULBERRIES (*MORUS*, MORACEAE)

Madhav P. Nepal

*South Dakota State University*
*Department of Biology and Microbiology*
*Brookings, South Dakota 57007, U.S.A.*
*Madhav.Nepal@sdstate.edu*

Carolyn J. Ferguson

*Kansas State University*
*Herbarium and Division of Biology*
*Manhattan, Kansas 66506, U.S.A.*

Mark H. Mayfield

*Kansas State University*
*Herbarium and Division of Biology*
*Manhattan, Kansas 66506, U.S.A.*

## ABSTRACT

Flowering plants exhibit a diverse array of sex expression patterns that become of particular interest when considered in the context of co-existing native-invasive congeners. This study presents findings on sex expression and sex ratio variation in two congeneric tree species, the native *Morus rubra* and the exotic *M. alba,* in the Flint Hills region of the Great Plains in the United States. Both species exhibited a subdioecious breeding system (with male, female and hermaphrodite individuals co-occurring within populations), and significantly male-biased sex ratios (i.e., males are more numerous than females). Cumulative sex ratio deviation was higher in the native *M. rubra* populations than in the exotic *M. alba*. Within-species sex ratio did not vary significantly among populations. In one focus study area surveyed over three years, most individuals were consistent in sex expression, but approximately 10% switched their sex at least once; the vast majority of these changes were between unisexual and hermaphrodite morphs. There was no size dependence of sex expression based on current sampling. Our results document subdioecy as the breeding system in these *Morus* species, and advance the group as an interesting study system for its reproductive biology.

Key Words: Breeding system, Moraceae, *Morus*, subdioecy, sex ratio, sex switch

## RESUMEN

Las plantas con flores exhiben un conjunto de patrones de expresión sexual que tiene particular interés cuando se considera en el contexto de sus congéneres nativos-invasores con los que coexisten. Este estudio presenta hallazgos sobre la expresión sexual y variación del ratio sexual en dos especies congenéricas arbóreas, la nativa *Morus rubra* y la exótica *M. alba*, en la región de Flint Hills de la Gran Llanura de los Estados Unidos. Ambas especies exhiben un sistema de cruzamiento subdioico (con individuos masculinos, femeninos y hermafroditas en las poblaciones), y ratios sexuales significantemente sesgados hacia los masculinos (ej. Los masculinos son más numerosos que los femeninos). La desviación acumulativa de la ratio sexual era más alta en las poblaciones de la nativa *M. rubra* que en la de la exótica *M. alba*. La ratio sexual intraspecífica no varía significativamente entre poblaciones. En un área de estudio estudiada durante tres años, la mayoría de los individuos eran consistentes eh la expresión sexual, pero aproximadamente el 10% cambiaban su sexo al menos una vez; la gran mayoría de estos cambios fueron entre morfos unisexuales y hermafroditas. No hubo dependencia del tamaño en la expresión sexual en el muestreo actual. Nuestros resultados documentan subdioecia como Sistema de cruzamiento en estas especies de *Morus*, y avanzan al grupo como un sistema de estudio interesante por su biología reproductiva.

## INTRODUCTION

Although an intriguing array of flowering plant sexual systems (= breeding systems) occurs in a hermaphroditism-dioecy continuum, the breeding systems of the majority of plants have not been extensively explored (Charlesworth 2006). Dioecy, in which male and female plants are separate, occurs in about 6% of angiosperms (Renner & Ricklefs 1995), and may have evolved from hermaphroditism to prevent inbreeding (Charlesworth & Charlesworth 1978; Thomson & Barrett 1981). Subdioecy, in which three sexual morphs (male, female and hermaphrodite) occur, is thought to be a transition in the hermaphroditism-dioecy continuum and has been documented for several plant species (e.g., Case et al. 2008). A sex ratio of 1:1 (male/female) is expected in an ideal population if the reproductive cost of being male is equal to that of being female (Fisher 1930). Plants have evolved several strategies for reproductive assurance that might result in a sex ratio deviation: the extent and

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pattern of such deviation vary from species to species, among flowering episodes and across populations along environmental gradients (reviewed in Queenborough et al. 2007). Although several studies have documented sex ratio variation between flowering episodes (e.g., Nicotra 1998; Morellato 2004), fewer studies have observed the same individuals for more than two flowering seasons (e.g., Yamashita & Abe 2002; Wheelwright & Logan 2004), and still fewer studies have included more than one species (e.g., Thomas & LaFrankie 1993; Queenborough et al. 2007). Sex expression studies over multiple flowering episodes can provide information on flowering frequency, size dependence, and stability of sex expression (Yamashita & Abe 2002; Nanami et al. 2004).

Spatial distribution of individuals can play an important role in the successful survival and reproduction of a species (House 1992; Stacy et al. 1996). For example, individuals of a wind-pollinated dioecious species may experience pollen limitation in areas distant from other individuals (Ashman et al. 2004). Aggregation of males and females may facilitate pollen transfer (Bawa & Opler 1975) if the habitat is homogeneous in terms of resources. Many species, however, exhibit spatial segregation of the sexes, where individuals are partitioned along a resource gradient with females predominantly occurring in the resource rich habitats (Bierzychudek & Eckhart 1988). There are other factors related to spatial distribution that affect the reproduction of dioecious species, such as distance between males and females (Mack 1997), flowering frequency (Bawa 1980), effective population size (Nunney 1995), and pollinator abundance and behavior (Stacy et al. 1996). Some strategies such as leaky dioecy and parthenocarpy have been suggested for reproductive assurance (Baker & Cox 1984; Venkatasamy et al. 2007). Production of fleshy fruits (Bawa 1980), woody perennial habit, multi-seeded fruits, and dispersal by birds are commonly associated with dioecy (Baker & Cox 1984). Size-dependent sex expression occurs when male and female individuals exhibit differential reproductive costs. Females generally have higher reproductive costs and are usually larger in size than males (Lloyd & Bawa 1984). In wind-pollinated dioecious plants, some studies have reported a higher cost of reproduction in females (Smith 1981; Murakami & Maki 1992) while other studies have shown a positive correlation between the male investment and plant size facilitating the dispersal of pollen (Freeman et al. 1980; Solomon 1989). Sex expression patterns in plants are interesting, as they play important roles in micro-evolutionary processes that involve reproductive success, inbreeding depression, fixation of deleterious recessive mutations (reviewed in Charlesworth 2006) and plasticity of sex expression (Delph & Wolf 2005).

Here we present our results on breeding systems and sex ratio variation of two species of the genus *Morus: M. rubra* L. and *M. alba* L. *Morus rubra* is distributed in eastern North America from the east coast to the eastern margin of the Great Plains, and extends northward to southern Ontario, Canada, where it occurs in isolated patches of woodlands (Wunderlin 1997). *Morus alba*, a native to China, was introduced into North America in the 1600s to establish a silkworm industry. After escaping cultivation, *M. alba* has successfully naturalized (Gleason 1952). It often co-occurs with the native *M. rubra* in forests, and open riparian woodlands. Additionally, *M. alba* commonly occurs in open areas; and it is considered ecologically invasive (Uva et al. 1997; Weber 2003). Indeed, the species constitute an interesting study system with many morphological similarities (and they sometimes hybridize; Burgess et al (2008); although they are not each other's closest relative; Nepal & Ferguson 2012). Relative to the native *M. rubra*, some studies have found *M. alba* to produce more pollen and seeds (Burgess et al. 2008), and better quality of fruits for dispersal by birds (Stapanian 1982). The invasion success of *M. alba* remains relatively unexplored, and may in part be attributable to complex reproductive behavior. *Morus* species have been treated as dioecious or monoecious in the taxonomic literature (e.g., Berg 2001), and their sexual systems have not been extensively explored. Both species produce unisexual flowers in catkins, and the catkins can be unisexual or bisexual. In the present study, we used census data collected over a three-year period for the native-invasive pair of *Morus* in the Flint Hills region of Kansas to address the following questions. What breeding systems do *M. alba* and in *M. rubra* exhibit? Do their sex ratios deviate from 1:1? And do sexual expression and sex ratios remain constant from a given year to the next?

## MATERIALS AND METHODS

We conducted field studies on populations of *M. alba* and *M. rubra* (22 populations total) in the Flint Hills region of north central Kansas. The Flint Hills region extends throughout an area of 29,600 $km^2$ in eastern Kansas and northern Oklahoma, and is a distinct grassland ecoregion in the Great Plains. Although the region is largely dominated by $C_4$ grasses, included riparian areas are dominated by woody plant species including *Celtis occidentalis*, *Quercus macrocarpa*, and *Q. muehlenbergii* (Great Plains Flora Association 1986). *Morus alba* is common in these habitats and additionally extends onto open prairie, whereas *M. rubra* persists in relatively natural riparian areas. Twenty two populations of mulberries from 13 sites near Manhattan, Kansas (nine sites where populations of *M. rubra* and *M. alba* grew together, and four where only *M. alba* was found), were investigated in the spring of 2005: Kings Creek and Shane Creek areas of Konza Prairie Biological Station (KPBS); Pottawatomie State Fishing Lake No. 1; Pottawatomie State Fishing Lake No. 2; Timber Creek Park and Farnum Creek Park areas of Milford Lake; Slough Creek Park area of Perry Lake; Frank Anneberg Park and part of the Linear Park Trail areas in Manhattan, Kansas; southeast and west areas of Tuttle Creek Lake; Three Mile Creek area of Fort Riley Military Reservation; as well as a privately owned riparian area along Kuenzli Creek southeast of Alma, Kansas (sect. 16). Representative voucher specimens were labeled and deposited at the Kansas State University Herbarium (KSC). Although the two species of *Morus* can hybridize, all of the individuals included in this study were readily identified as to species (see Nepal et al 2012).

For each tree, ten to twelve flowering branches growing at varying heights were assessed for sex expression. In addition, nearest neighbor distance (NND) and diameter at breast height (DBH) were measured. The population along Kings Creek was chosen for study of inter-year variation in sex expression; each tree was tagged with a tree identification number and studied during three flowering episodes (2005, 2006, and 2007).

Sex ratio was expressed as a proportion of males to the sum of males and females. Deviation of sex ratios from the unity was tested using $\chi^2$ statistics. Inter-year variation in sex ratio was analyzed with proportion of males as the response variable using GENMOD procedure in Statistical Analysis System 9.0 (SAS). To test the statistical difference between the proportion of males in two species, generalized linear models were used with binomial distribution and the logit link function (Crawley 1993). Variation of sex ratio within each species was analyzed across the populations and compared between species. To quantify size dependence of sex expression, a GENMOD procedure with gamma distribution was used with DBH as a response variable. Parameter estimates were analyzed by maximum likelihood and p-values were calculated using $\chi^2$ statistics. Similar analyses were performed in SAS to analyze the relationship between distance and sex expression as hermaphroditism. The relationships between DBH and NND were analyzed using REG procedure in ANOVA with DBH as the response variable.

## RESULTS

### Breeding System, Sex Ratios and Lability of Sexual Expression

Out of 408 *M. rubra* trees studied across nine populations, 42 trees (10.3%) were hermaphrodites, and out of 269 *M. alba* trees across thirteen sites, 32 trees (12.3%) were hermaphrodites (Table 1)—establishing that both species exhibit a subdioecious breeding system with males, females and hemaphrodites (see also below, regarding labile sex expression). In addition, the ratio of males to females deviated significantly from a 1:1 ratio with the proportion of males being greater than that of females for each species (Fig. 1): $\chi^2$ 1 = 17.36 for *M. alba*, $\chi^2_1 = 44.99$ for *M. rubra*, and p = <0.0001 for each species. The cumulative sex ratio between the two species didn't differ significantly ($\chi^2_1 = 1.26$, p = 0.2623), but was more strongly male-biased in *M. rubra*. Inter-year sex ratio variation was not significant within each species ($\chi^2_2 = 1.71$, p = 0.4262 for *M. alba*;$\chi^2_2 = 0.06$, p = 0.9701 for *M. rubra*; Table 2); however, the interspecific difference in sex ratio was significant ($\chi^2_1 = 11.26$, p = 0.001). The proportion of males of *M. alba* increased in 2007 due to mortality of two female trees to fire, and some sex switching (see below). The sex ratios were consistently male-biased for both species for all the three years.

Sex ratios were consistently male-biased across all populations (Figs. 2, 3). Interpopulation variation in sex ratio within species was not statistically significant ($\chi^2_{12} = 7.70$, p = 0.86 for *M. alba*; $\chi^2_8 = 5.60$, p = 0.69 for

Table 1. Sampled sites with the information on sample size (N) and number of males (M), females (F) and hermaphrodites (H) for *Morus alba* (MA) and *M. rubra* (MR).

| Sampled site | Species | N | M | F | H |
|---|---|---|---|---|---|
| Alma: along Kuenzli Creek, Wabaunsee Co. | MA | 12 | 7 | 4 | 1 |
| | MR | 25 | 14 | 10 | 1 |
| Anneberg Park: City of Manhattan, Riley Co. | MA | 15 | 7 | 6 | 2 |
| | MR | 31 | 15 | 11 | 5 |
| Fort Riley: along Three Mile Creek, Riley Co. | MA | 14 | 7 | 5 | 2 |
| | MR | 48 | 28 | 14 | 6 |
| Kings Creek: KPBS, Riley Co. | MA | 38 | 20 | 8 | 10 |
| | MR | 74 | 46 | 15 | 13 |
| Linear Park Trail: along Wildcat Creek, Riley Co. | MA | 51 | 29 | 16 | 6 |
| Farnum Creek: Milford Lake, Geary Co. | MA | 12 | 6 | 4 | 2 |
| Timber Creek: Milford Lake, Clay Co. | MA | 11 | 7 | 3 | 1 |
| Pottawatomie Lake No. 1: Pottawatomie Co. | MA | 45 | 28 | 12 | 5 |
| Pottawatomie Lake No. 2: Pottawatomie Co. | MA | 13 | 7 | 5 | 1 |
| | MR | 75 | 48 | 24 | 2 |
| Shane Creek: KPBS, Riley Co. | MA | 5 | 3 | 2 | 0 |
| | MR | 35 | 26 | 8 | 1 |
| Slough Creek: Perry Lake, Jefferson Co. | MA | 8 | 4 | 3 | 1 |
| | MR | 78 | 45 | 24 | 9 |
| Tuttle Creek SE: Beach Drive below dam, Pottawatomie Co. | MA | 37 | 21 | 15 | 1 |
| | MR | 32 | 19 | 9 | 4 |
| Tuttle Creek West: Observation Point Drive west of dam, Riley Co. | MA | 8 | 5 | 3 | 0 |
| | MR | 11 | 7 | 3 | 1 |

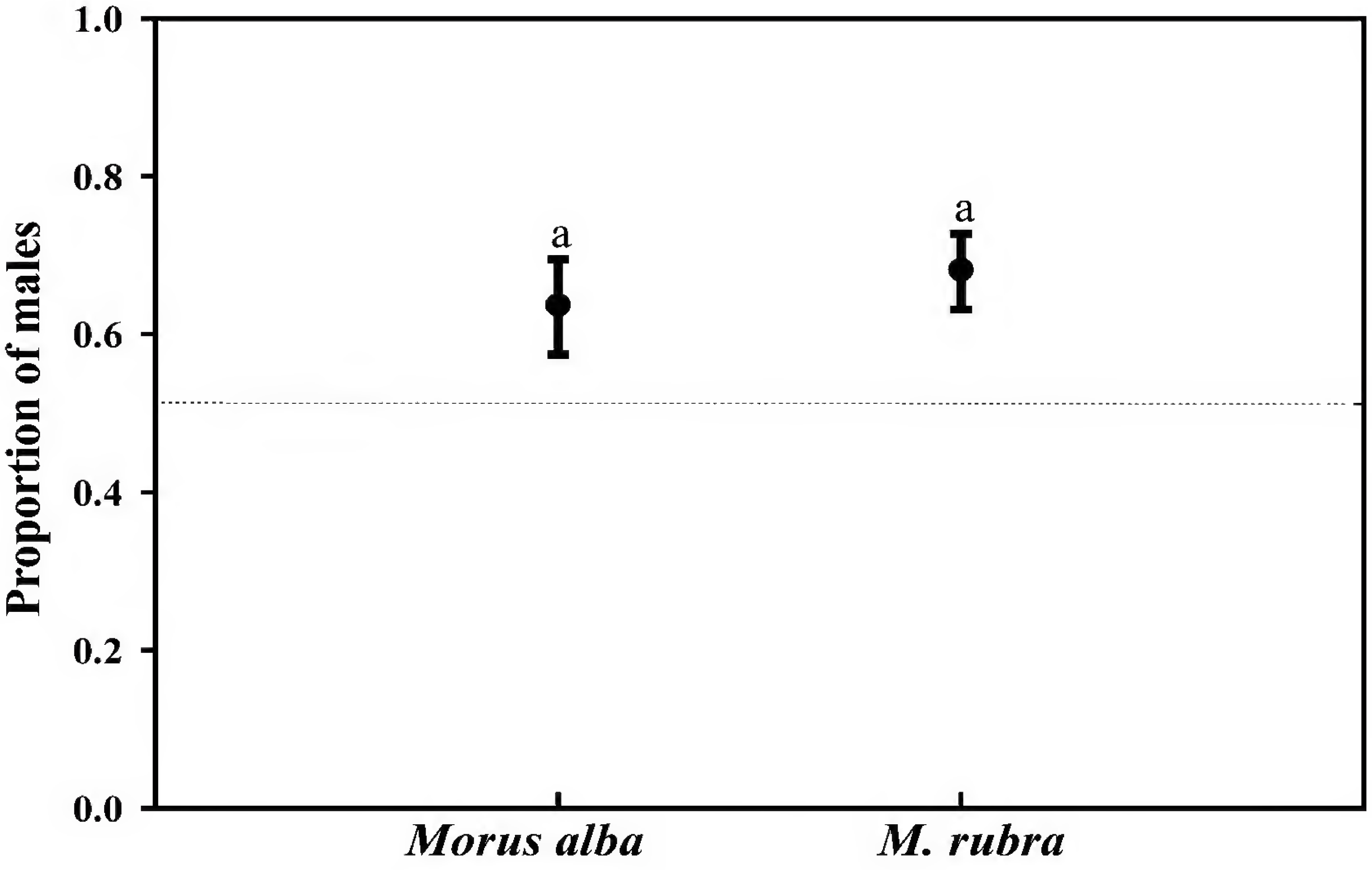

Fig. 1. Sex ratio deviation in *Morus* in the Flint Hills region of Kansas. Sex ratio is expressed as the proportion of males (males / [males + females]; hermaphrodites not included). 95% confidence intervals are indicated. The line at 0.5 on y-axis corresponds a 1:1 ratio of males to females (i.e. equal numbers of males and females; values above 0.5 indicate more males than females). The letter "a" indicates a significant deviation of sex ratio from 1:1.

Table 2. Inter-year sex ratio in *Morus* at Kings Creek. Sex ratio is expressed as the proportion of males, and the 95% confidence limits (CL) are indicated. Values denoted by similar letters are not significantly different from each other. Chi Square probability of deviation at 0.5 of alpha, degree of freedom and sample size are represented by p (χ2), df and N, respectively. The hermaphrodites were not included in the analysis. Significant sex ratio deviation from unity is marked with an asterisk.

| Species | Year | 2005 | 2006 | 2007 |
|---|---|---|---|---|
| ***Morus alba*** | Sex ratio | 0.5937 | 0.6060 | 0.7407 |
| | Upper CL | 0.4192 | 0.4335 | 0.5471 |
| | Lower CL | 0.7474 | 0.7556 | 0.8710 |
| | p (χ2) | 0.2917 b | 0.2268 b | 0.0168 b* |
| | df | 1 | 1 | 1 |
| | N | 32 | 33 | 27 |
| ***Morus rubra*** | Sex ratio | 0.7666 | 0.7666 | 0.7500 |
| | Upper CL | 0.6436 | 0.6436 | 0.6258 |
| | Lower CL | 0.8566 | 0.8566 | 0.8433 |
| | p ( χ2) | <0.0001 a* | <0.0001 a* | 0.0002 a* |
| | df | 1 | 1 | 1 |
| | N | 60 | 60 | 60 |

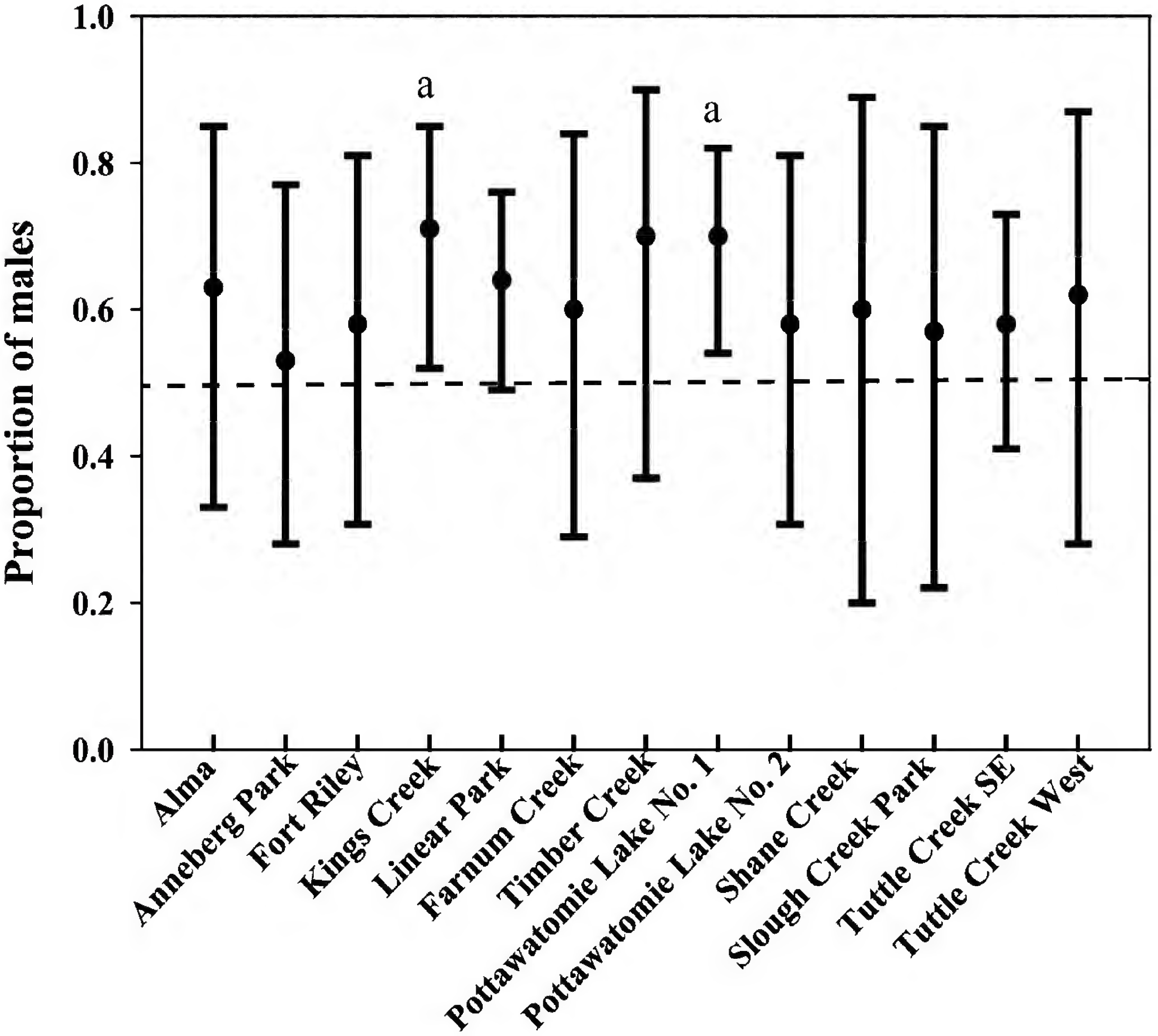

Fig. 2. Sex ratio variation with 95% confidence intervals across 13 populations of *M. alba* in the Flint Hills region of Kansas. Sex ratio is expressed as the proportion of males. The letter "a" indicates a significant deviation of sex ratio from 1:1.

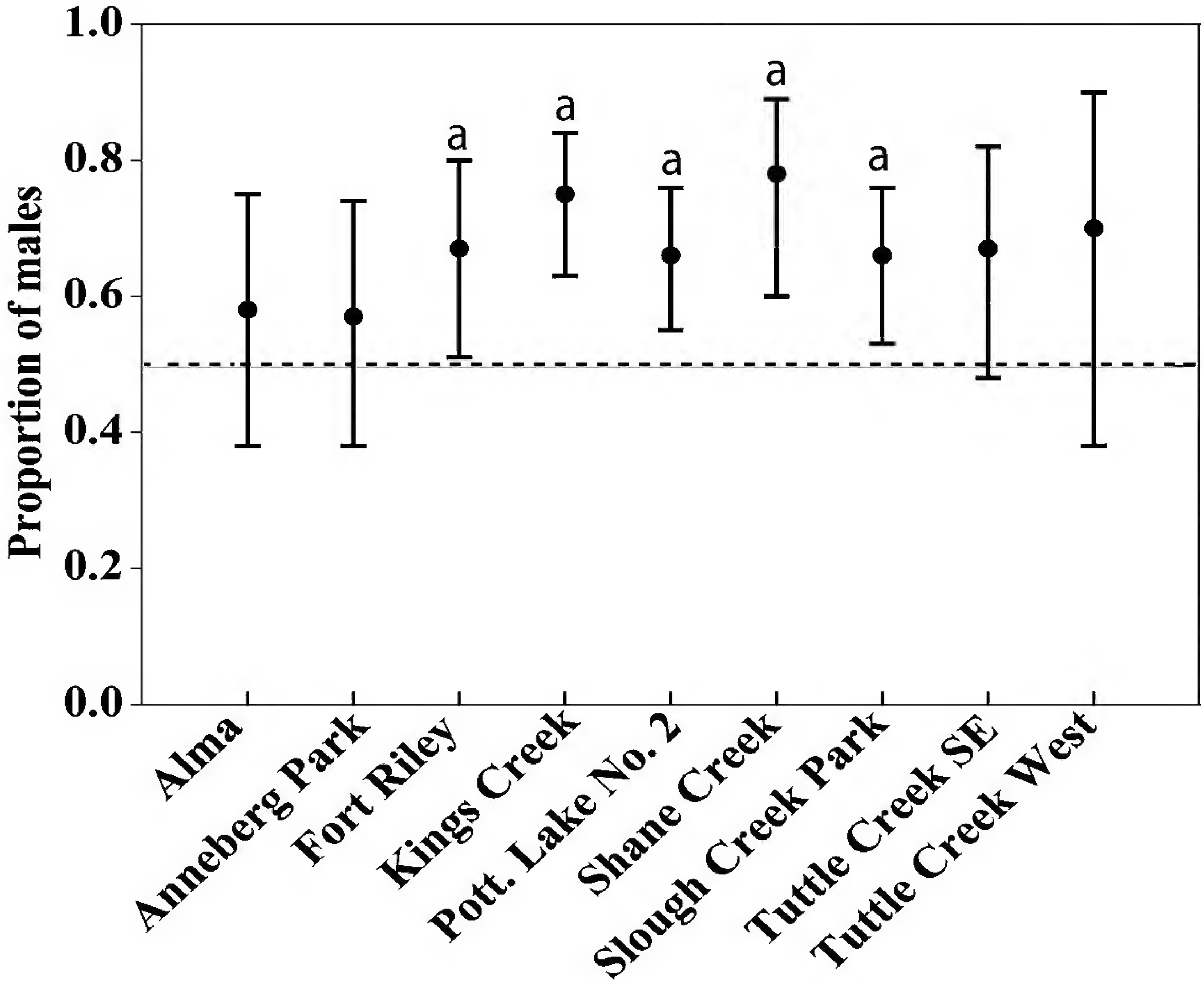

**Fig. 3. Sex ratio variation with 95% confidence intervals across nine populations of *M. rubra* in the Flint Hills region of Kansas. Sex ratio is expressed as the proportion of males. The letter "a" indicates a significant deviation of sex ratio from 1:1.**

*M. rubra*). Two *M. alba* populations, Kings Creek and Pottawatomie Lake No.1, were significantly male-biased ($\chi^2_1 = 4.80$, $p < 0.05$ and $\chi^2_1 = 6.03$, $p < 0.05$, respectively; Fig. 2); and five *M. rubra* populations were significantly male-biased: Fort Riley ($\chi^2_1 = 4.69$, $p < 0.05$), Kings Creek ($\chi^2_1 = 14.20$, $p < 0.001$), Shane Creek ($\chi^2_1 = 8.86$, $p < 0.01$), Pottawatomie Lake No. 2 ($\chi^2_1 = 7.69$, $p < 0.05$), and Slough Creek ($\chi^2_1 = 6.54$, $p < 0.05$; Fig. 3). When compared between species, the sex ratio of *M. rubra* was consistently more strongly male-biased than that of *M. alba*.

Out of 75 *M. rubra* trees observed at Kings Creek across three years (2005, 2006 and 2007), changes in sexual expression (among female, male and hermaphrodite morphs) were rarely observed: 5% (4 trees) switched sex from 2005-2006, and 8% (6 trees) changed sex from 2006-2007 (Table 3). Of those trees that changed sexual status, only one of them changed sex both years. Among 38 *M. alba* trees studied, four trees exhibited six changes in sex expression (three changes from 2005-2006 and three from 2006-2007; two trees changing both years). In all but one case (a single observed female to male change in *M. alba* tree #267), changes involved switching among unisexual and hermaphrodite conditions (Table 3). Furthermore, while we observed interesting variation in distribution of male and female flowers on individual hermaphrodite trees (e.g., male and female flowers on separate catkins vs. mixed catkins with flowers of both sexes), we highlight the variation with respect to functional sex expression of the individual plant (male, female, hermaphrodite; Table 3).

### Sex Expression Relative to Size and Nearest Neighbor Distance

The size distribution of all sexual morphs in both species is shown in Fig. 4. No significant differences in size

Table 3. Change of sexual status in *Morus* at Kings Creek between 2005, 2006 and 2007. M = male, F = female, MF = hermaphrodite with mixed catkins, and M+F = hermaphrodite tree with male and female catkins on separate branches. Functional changes (i.e., excluding changes among different expressions of hermaphroditism: M+F, MF) are shown in bold face font and discussed in the text.

| *M. alba* | Sexual status change | | *M. rubra* | Sexual status change | |
|---|---|---|---|---|---|
| Tree ID | 2005 ➔ 2006 | 2006 ➔ 2007 | Tree ID | 2005 ➔ 2006 | 2006 ➔2007 |
| 264 | **M+F+MF ➔ M** | **M ➔ M+F** | 5 | M | **M ➔ M+F** |
| 267 | **M+F+MF ➔ F** | **F ➔ M** | 7 | **M+F ➔ F** | F |
| 284 | **F ➔ M+F** | M+F | 45 | M+F | **M+F ➔ F** |
| 294 | F | **F ➔ M+F** | 49 | F | **F ➔ M+F** |
| | | | 50 | M+F ➔ M+F+MF | M+F+MF |
| | | | 62 | M+ F ➔ MF+M+F | M+F+MF ➔ M+F |
| | | | 67 | F | **F ➔ M+F** |
| | | | 76 | M+F ➔ M+F+MF | **M+F+MF ➔ F** |
| | | | 77 | **M+F ➔ M** | M |
| | | | 85 | M+F ➔ M+F+MF | M+F+MF |
| | | | 88 | M+F ➔ M+F+MF | M+F+MF |
| | | | 92 | **F ➔ M+F** | M+F |
| | | | 100 | **F ➔ M+F** | **M+F ➔ F** |

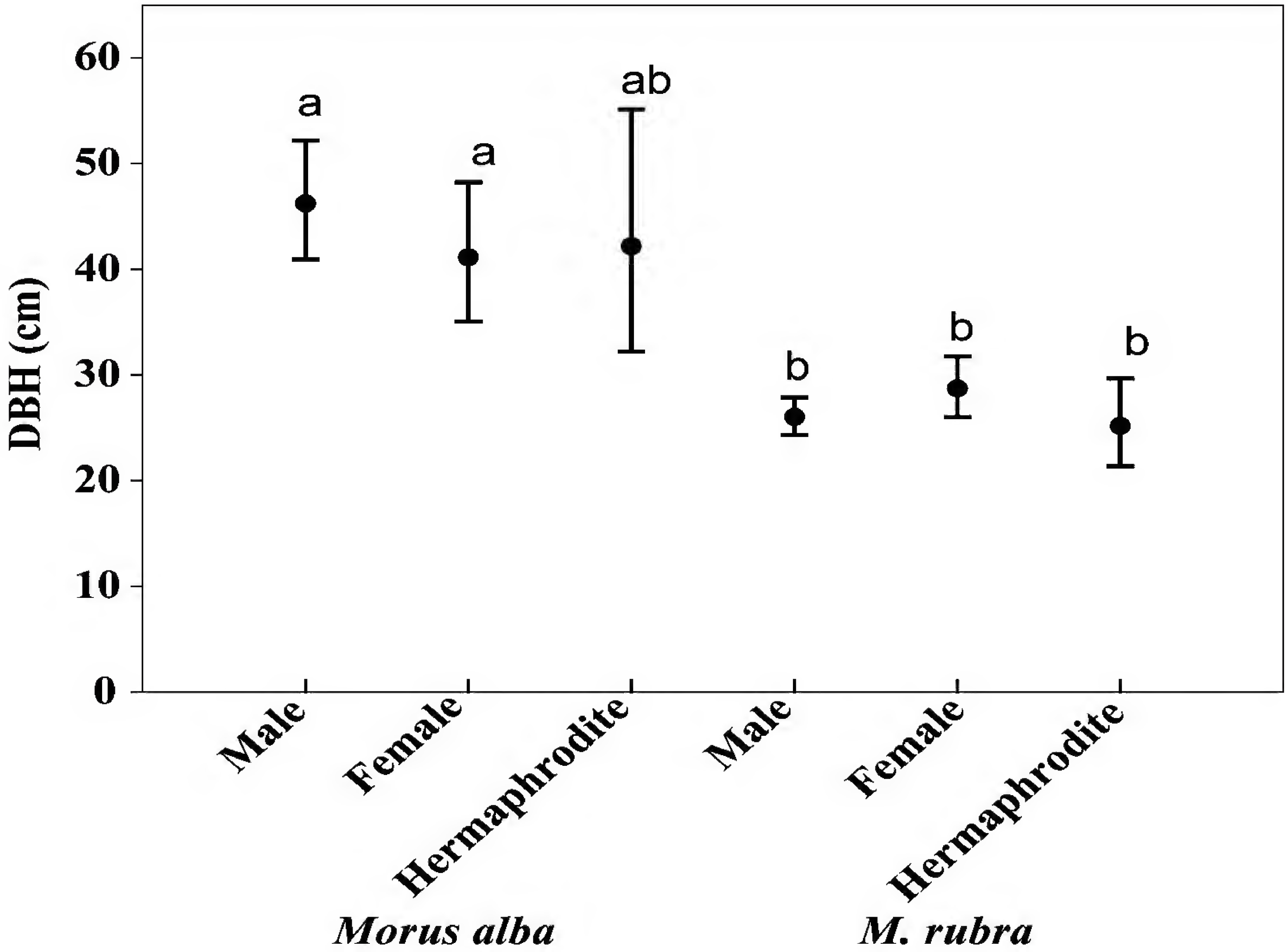

**Fig. 4. Size of *Morus* trees in the Flint Hills region of Kansas relative to sexual morph. The symbols represent mean DBH with 95% confidence intervals.**

among male, female and hermaphrodite individuals were found within species ($\chi^2{}_2 = 1.41$, p = 0.49 for *M. alba*; $\chi^2{}_2 = 3.12$, p = 0.21 for *M. rubra*). Males and females of *M. alba* were statistically larger than those of *M. rubra* (Fig. 4). In *M. alba*, the sex ratio did not differ from 1:1 in the smaller size classes (DBH <20 cm), but differed significantly at larger size classes and was male-biased. In *M. rubra*, the sex ratios differed from 1:1 in all size classes. Regression analysis showed no association between the size of the tree (DBH) and the nearest neighbor distance (NND) for both *M. alba* ($r^2 = 0.0032$, $p = 0.52$) and *M. rubra* ($r^2 = 0.0013$, $p = 0.46$).

The average nearest neighbor distance for hermaphrodites was significantly greater than that for males and females ($\chi^2{}_2 = 28.91$, $p < 0.0001$ for *M. alba*; $\chi^2{}_2 = 51.41$, $p < 0.0001$ for *M. rubra*; Fig. 5). This pattern was based on average distances, whereas there were some individual hermaphrodites occurring near other individuals, and some males and females occurring at more distant locations. The average nearest neighbor distance did not differ between males and females within each species or between the two species.

## DISCUSSION

### Subdioecy, Sex Ratios and Lability of Sex Expression

Our study documents subdioecy in *M. alba* and *M. rubra*. Across 22 populations in the Flint Hills of Kansas (13 of *M. alba* and nine of *M. rubra*), the majority of the trees are consistently unisexual, but approximately 10% of the individuals are hermaphrodites. Moreover, focused study of populations at Kings Creek over three years found that 10-12% of individuals changed sexual expression (among male, female and hermaphrodite sexual morphs) at least once across these years; all but one of these observed changes were between unisexual and hermaphrodite conditions. There was no unidirectional change in sex expression across years (i.e., unisexual individuals switched from one sex to another or to hermaphroditism, and the hermaphrodites switched to being unisexual; Table 3), and all of the changes occurred in plants that expressed hermaphroditism in at least one year. The subdioecious breeding system in the studied species of *Morus* might represent a transition in the hermaphroditism-dioecy continuum, and could be an adaptive strategy, as previously discussed (see Case et al. 2008), for reproductive assurance by opportunistic selfing, benefitting sexual specialization and avoiding the effect of inbreeding depression. The evolution of subdioecy is believed to have occurred through a monoecy-paradioecy pathway (where individuals in the population are selected for in such a way that one becomes increasingly male and the other becomes increasingly female by gradual divergence; Delph & Wolf 2005).

In the present study, both *M. alba* and *M. rubra* had some individuals that exhibited sex expression plasticity. Such a strategy is not considered very common in woody perennials, although it is common in herbaceous dioecious species (Korpelainen 1998). Some examples of tree species with plasticity in sex expression include *Acer rubrum* (Sakai 1990), *Acer rufinerve* (Nanami et al. 2004), *Bischofia javanica* (Yamashita & Abe 2002), *Clusia nemorosa* (Lopes & Machado 1998), *Dombeya ciliata* (Humeau et al. 2000), *Dombeya delislei* (Humeau et al. 1999), *Hebe subalpina* (Delph 1999), *Lindera benzoin* (Primack 1985), *Myristica insipida* (Armstrong & Irvine 1989), and *Thymelaea hirsuta* (El-Keblawy & Freeman 1999). Effects of environmental factors on sex expression were highlighted in all of these studies except in the case of *A. rufinerve*, where deteriorating plant health resulted in a change from male to female. Males of some plant species are reported to be inconstant, as in *D. ciliata* (Humeau et al. 2000), *D. delislei* (Humeau et al. 1999), and *C. nemorosa* (Lopes & Machado 1998). In *Morus*, while the majority of the trees were male or female, some males and females were inconstant/labile from a given year to the next. These findings are similar to those of reports on *B. javanica* (Yamashita & Abe 2002) and *T. hirsuta* (El-Keblawy & Freeman 1999), wherein both sexes were inconstant. This labile sex expression in *Morus* may have evolved for successful reproduction under unpredictable environmental conditions, ensuring outcrossing and the maintenance of genetic variation within populations.

In some other subdioecious species, studies have shown that sex expression is determined by both genetics and by genotype - environment interactions. In *Atriplex canescens*, sex of the majority of unisexual individuals was genetically fixed as male or female, while sex varied in other individuals ranging from unisexual individuals to hermaphrodites with various proportions of male and female flowers (McArthur et al. 1992). In *Rumex nivalis*, sex expression was largely determined by genetics, however sex ratios in the progeny depended on pollination intensity (Stehlik et al. 2008). In *Morus*, as the majority of the individuals are consistently male or female and only a small number of individuals are inconstant, as in the case of *Atriplex* (McArthur et al. 1992), sex expression may be controlled by both genetics and genotype - environment interactions. Further

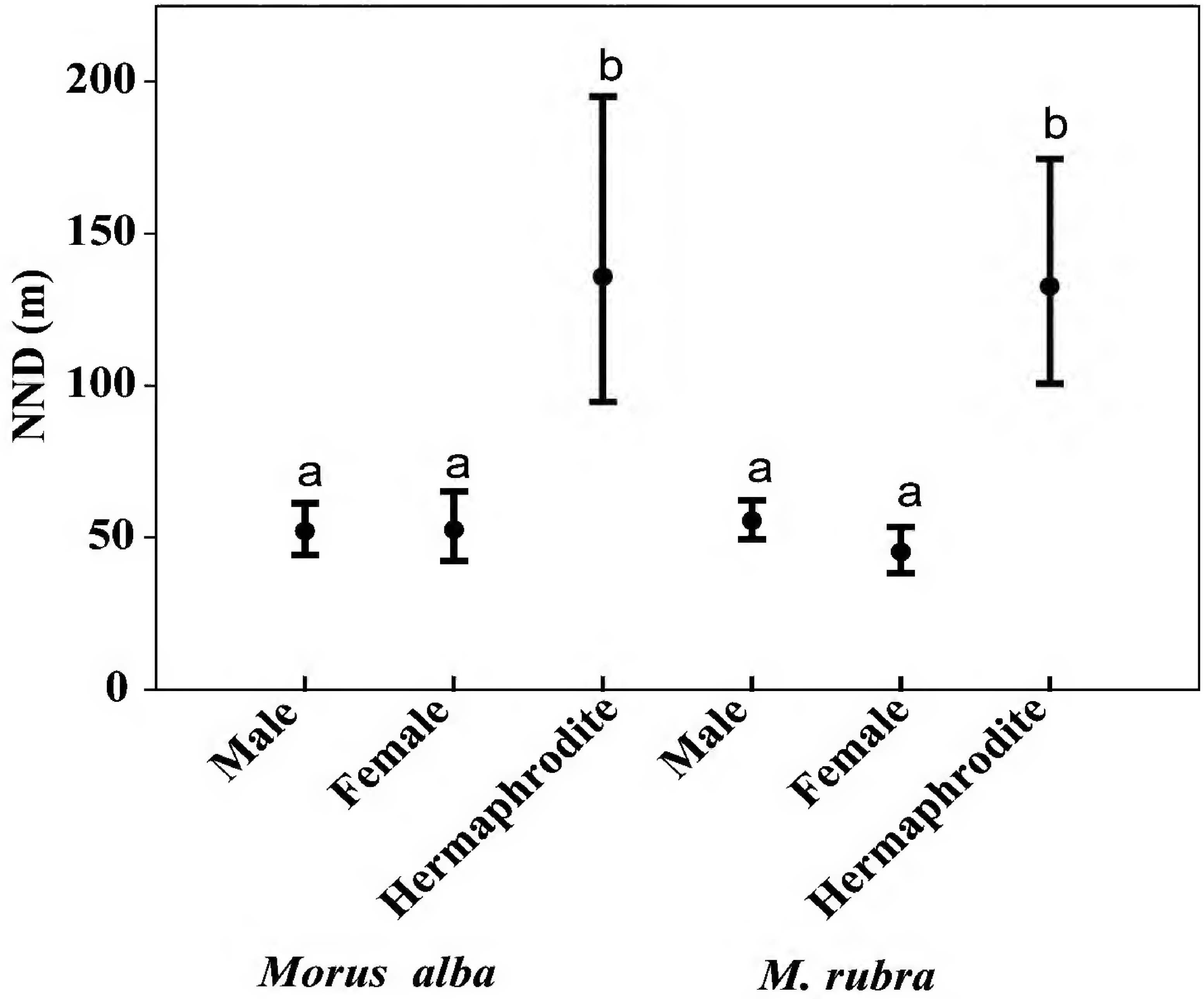

Fig. 5. Relationships between the nearest–neighbor-distance (NND) and sex types in *Morus*. The symbols denote mean with 95% confidence intervals.

investigation on the effects of environmental factors on sex determination may provide insights into the maintenance of subdioecy in *Morus*.

### Groundwork for Future Studies Investigating Patterns

In the present study, both species exhibited significant sex ratio deviations. The male-biased sex ratios in mulberries are in line with those reported in other dioecious species (see Bierzychudek & Eckhart 1988; House 1992; Thomas & LaFrankie 1993; Nicotra 1998). These studies have provided proximate causes of male-biased sex ratios as precocious male flowering, more frequent flowering of males than females (Thomas & LaFrankie 1993; Nicotra 1998) and higher female mortality (Bierzychudek & Eckhart 1988). For most dioecious species with known sex ratios, sex ratios are consistently male-biased (Delph 1999). Species such as *Compsoneara spucei* (Bullock 1982), *Myristica insipida* (Armstrong & Irvine 1989), and *Rhamnus alaternus* (Guitihn 1995) have a stable sex ratio (i.e., 1:1), while species such as *Rumex acetosa* (Korpelainen 1998) have female-biased sex ratios. *Acer negundo* shows male-biased sex ratios in drier habitats and female-biased sex ratios in the moist areas (Jing & Coley 1990). Unlike in *Morus*, Yamashita and Abe (Yamashita & Abe 2002) show significant inter-year variation in sex ratios in *Bischofia javanica*, with a large number of individuals switching their sex. The observed inter-year variation in sex expression in both species of *Morus* studied warrants further investigation.

Size dependent sex expression has been documented in several dioecious species including *Bischofia* *javanica*: the smallest trees were males, medium sized trees inconstant and the largest trees were females (Yamashita and Abe 2002). We found no size dependence of sex expression in *Morus*. In *M. alba*, however, the frequency of males at the higher size class was higher than those at the smaller size classes (Fig. 4). If male and female individuals differ in reproductive costs, allocation would be greater in the sex with higher reproductive costs, resulting in size difference in the sexes (Lloyd & Bawa 1984). Absence of inter-sex difference in size in *Morus* suggests that male and female individuals do not differ in reproductive costs (the cost of pollen production in males is comparable to the production in females of fruits). In order to gain insights into reproductive allocation in *Morus*, further studies—including identifying the resources that drive expression of one sex versus the other—are needed.

Stehlik et al. (2008) demonstrated that the proximity of males and females affected the sex ratios in *Rumex nivalis*: the closer the males and females, the stronger were the female-biased sex ratios. In *Morus*, we did not detect an association between tree size and the nearest neighbor distance. The *Morus* species are mostly understory trees with patchy distributions (particularly *M. rubra*), and they may be experiencing pollen limitation rather than pollen excess (Ashman et al. 2004). Male-biased sex ratios in these species occurring in a heterogenous environment may therefore ensure outcrossing and reduce the cost of selfing.

We found no strict spatial segregation of the sexes (SSS) in *Morus* in the populations studied. In species that do exhibit SSS such as *Acer negundo* (Freeman et al. 1997), and *Juniperus virginiana* (Lawton & Cothran 2000), females often dominate in resource rich habitats (Lloyd & Bawa 1984). Since *Morus* species are sparsely distributed understory trees and pollen movement from tree to tree is essential for reproductive success, the individuals of the same species are less likely to compete for the same limiting resources. Therefore, the species are less likely to undergo selection for SSS that would further reduce the reproductive success. Our findings are similar to those for *Silene grandiflora*, an understory plant that did not exhibit SSS (Bawa & Opler 1975). Some studies have suggested several factors related to spatial distribution that affect the reproduction of dioecious species such as distance between males and females (Mack 1997), flowering frequency, effective population size (Nunney 1995), pollinator abundance and flight behavior (Stacy et al. 1996), etc. Some strategies of plants such as woody perennial habit (Baker & Cox 1984), production of fleshy fruits (Bawa 1980), production of multi-seeded fruits and dispersal by birds (Baker & Cox 1984), leaky dioecy, and parthenocarpy (Venkatasamy et al. 2007) for reproductive assurance have been suggested. The two species of *Morus*, which are subdioecious, woody perennials, parthenocarpic (Barbour et al. 1973), and produce multi-seeded fleshy fruits that are dispersed by birds–all potential strategies for reproductive assurance.

Our study found similar reproductive strategies in *M. alba* and *M. rubra* in the Flint Hills region of the Great Plains: each species exhibits a subdioecious breeding system, with a male-biased sex ratio and some lability in sexual expression. These findings in the two species raise the question of whether similar reproductive biology may be common in the genus. We did not find evidence for size dependence of sex expression. Hermaphrodites were, on average, located farther from other plants than were unisexual individuals (although this general pattern was based on average distances; hermaphrodites sometimes occur in close proximity to males and females). This work suggests many avenues for future study; in particular, further investigation on the role of pollen limitation may shed light on the biological significance of patterns and changes in sexual expression in *Morus*. Future multi-year studies including additional individuals and populations will be valuable. Documentation of breeding systems of these species advances our basic understanding of the taxa and furthers *Morus* as an interesting study system for studies of reproductive and evolutionary biology.

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**Errata**

# FROM CRO-MAGNON TO KRAL: A HISTORY OF BOTANY IN ALABAMA

L.J. Davenport

*Biological & Environmental Sciences*
*Samford University*
*Birmingham, Alabama 35229, U.S.A.*
*ljdavenp@samford.edu*

## ABSTRACT

Due to its great diversity of terrestrial and aquatic habitats, from mountains to the Gulf coast, Alabama supports an inordinate number of species, including several thousand vascular plants. These species are distributed, from north to south, across the Interior Plateau, Piedmont, Southwestern Appalachian, Ridge & Valley, Southeastern Plains, and Southern Coastal Plain ecoregions.

Alabama's plant life has been studied and utilized since ancient times. Such studies began with Paleo-Indians, Native Americans, and European explorers. During the early 1800s, the major botanical "players" were pioneers, settlers, travelers, academics, and medical doctors. The latter half of the 19th century was defined by the works of Mobile pharmacist Charles Mohr, culminating in his 1901 magnum opus, *Plant Life of Alabama*. Roland Harper, working mainly through the Geological Survey of Alabama, dominated the first half of the twentieth century. Floristic studies have taken hold since 1950, with "hotbeds" for such studies established at each of the state's universities.

No current botanist stands as tall as Robert Kral. His voluminous knowledge of Alabama's flora has been recorded in monographs, revisions, federal reports, floristic accounts, checklists, and websites. His thousands of Alabama specimens, now housed at BRIT, constitute a botanical treasure of inimitable value.

## RESUMEN

Debido a la gran diversidad de hábitats terrestris y acuáticos, de las montañas a la costa del Golfo, Alabama soporta un enorme número de especies, que incluyen varios miles de plantas vasculares. Estas especies están distribuidas, de norte a sur, a través de la Meseta Interior, de las ecorregiones Piedemonte, suroeste de los Apalaches, cadena y valle, llanuras del sureste, y llanura costera sur.

La vida vegetal de Alabama ha sido estudiada y utilizada desde los tiempos antiguos. Tales estudios empiezan con los paleo-indios, americanos nativos, y exploradores europeos. Durante los 1800s tempranos, los mayores actores botánicos fueron los pioneros, colonos, viajeros, académicos, y doctores en medicina. La última mitad del siglo XIX estuvo definida por los trabajos del farmacéutico ambulante Charles Mohr, que culmina en su opera magna de 1901, *Plant Life of Alabama*. Roland Harper, trabajando principalmente para el Geological Survey de Alabama, domino la primera mitad del siglo XX. Los estudios florísticos se han sucedido desde 1950, con "semilleros" para tales estudios establecidos en cada universidad estatal.

Ningún botánico actual sobresale tanto como Robert Kral. Su voluminoso conocimiento de la flor de Alabama se ha recogido en monografías, revisiones, informes federales, informes florísticos, catálogos, y páginas web. Sus miles de especímenes de Alabama, actualmente en BRIT, constituyen un Tesoro botánico de inimitable valor.

Alabama is blessed with a tremendous diversity of species. Although 30th among the United States in total land area, the state ranks first for its number of known species among the 26 states east of the Mississippi River (Duncan 2013). A recent checklist by Kral et al. (2011) records 3743 species of Alabama vascular plants alone. Such high rankings and high numbers are due directly to the diversity of habitats available to be colonized.

## GENERAL PHYSIOGRAPHY AND ECOREGIONS

Several attempts have been made to document and categorize Alabama's plant communities and ecoregions, including those by Mohr (1901) and Harper (1943a). The current system, devised by Griffith et al. (2001), is described below (roughly from north to south); a variety of very detailed maps can be downloaded from the accompanying website (see References).

The Interior Plateau Ecoregion extends from southern Indiana to northern Alabama. Its tablelands and plains, cut by the west-flowing Tennessee River, developed over Mississippian to Ordovician limestones, sandstones, and shales. Originally covered by deciduous forest, this ecoregion (centered around the city of Huntsville) was an important agricultural area much favored by early settlers.

The Southwestern Appalachian Ecoregion, stretching to Kentucky, enters Alabama in its northeast corner, along with the Tennessee River. The Mississippian to Ordovician limestones, dolomites, and shales of the

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Sequatchie Valley subunit create an agriculturally rich area. Much of another important subunit—called either the Shale Hills, Warrior Coal Field, Coal Basin, or Coal Measures—has been strip-mined, with concomitant alterations of land forms, drainage patterns, soils, and vegetation. The Dissected Plateau subunit contains plant species, such as eastern hemlock (*Tsuga canadensis*) and many rare ferns, that migrated south during the Ice Ages and remain in its cool, protected ravines.

The Ridge & Valley Ecoregion stretches southwest from Pennsylvania, entering Alabama near its northeastern corner and ending near its geographic center. Here parallel ridges and valleys, created by much folding and faulting, are wedged between the Piedmont to the east and the Interior Plateau to the west. A variety of geologic materials underlie this ecoregion, including the iron ore of Red Mountain near Birmingham. Drainage is largely through the Cahaba and Coosa river systems, flowing generally southwest.

The Piedmont is a triangular ecoregion jutting into central Alabama from the eastern (Georgia) border. Its fine-textured soils have developed over a mixture of Precambrian and Paleozoic metamorphic and igneous rocks. This ecoregion contains the highest elevations in the state, including Mount Cheaha (2407 ft), and once housed extensive montane longleaf pine (*Pinus palustris*) forests, which were logged out in the 1890s (Harper 1943a). Drainage is via the Tallapoosa and Coosa rivers, which combine to form the Alabama River east of Montgomery, the state capital.

The Southeastern Plains Ecoregion developed over the Cretaceous and Tertiary sands, silts, and clays of former coastlines. Its many subdivisions take up most of the state, running in broad bands from Alabama's northwest corner nearly to the Gulf of Mexico in the south. Several distinctive subunits are found here, including the Blackland Prairie or Black Belt "cinching" the midsection of the state. Here the fertile soils developed from Cretaceous chalks, supporting eastern red-cedar (*Juniperus virginiana*) and patches of bluestem prairie. (The prehistoric extent of Alabama's prairies was apparently not continuous and has led to much debate; see Rostlund [1957], Jones & Patton [1966], and Barone [2005]). Another unique subunit, the Dougherty Plain or Wiregrass Region, occupies the southeastern corner of the state. This karst topography contains many sinkholes and springs, while the sandy soils once supported park-like growths of longleaf pines maintained by frequent wildfires.

The Southern Coastal Plain Ecoregion extends from South Carolina through Georgia and Florida to Alabama, then west through Mississippi and Louisiana. In Alabama, much of this ecoregion consists of the Floodplains & Low Terraces subunit of the Mobile or Tensaw Delta, a series of swamps and backwaters based on river alluvium. A second subunit, the Gulf Barrier Islands & Coastal Marshes, consists largely of saline marshes, pine forests, and sand dunes. Much of this final subunit—especially the Fort Morgan Peninsula and Dauphin Island, twin sentinels "guarding" the entrance to Mobile Bay—serve as important refueling areas for birds and butterflies during their annual trans-Gulf migrations.

## NATIVE ALABAMIANS AND THEIR PLANT USES

Alabama has a rich Native American history. The state's very name—as well as many counties, towns, rivers, and natural landmarks—bear witness to this history (for examples, see Foscue 1989).

The four main groups of Native Americans occupying prehistoric Alabama were the Chickasaws, Cherokees, Creeks (including the Alabamas), and Choctaws. The Chickasaws and Cherokees inhabited the northernmost portions of the future state, including the Tennessee Valley of the Interior Plateau and Southwestern Appalachians. The Creeks ruled the diverse ecoregions of the majority of the state except for its western edge, which was held by the Choctaws.

The hunter-gatherer predecessors of these four tribes left their marks on Alabama, most notably (and quite literally) in Russell Cave (Fig. 1) in the Southwestern Appalachian Ecoregion near the Tennessee border. Excavations at this seasonal campsite began in 1951, revealing its use by hunter-gatherers from the Paleo-Indian Period (about 10,000 years ago) through late Woodland times (to 1000 CE). Unfortunately, these excavations concentrated on point types and potsherds and ignored direct evidence of plant use, like carbonized seeds and shells. But some indirect evidence exists—pits for storage of nuts and seeds, plus "nut stones" for

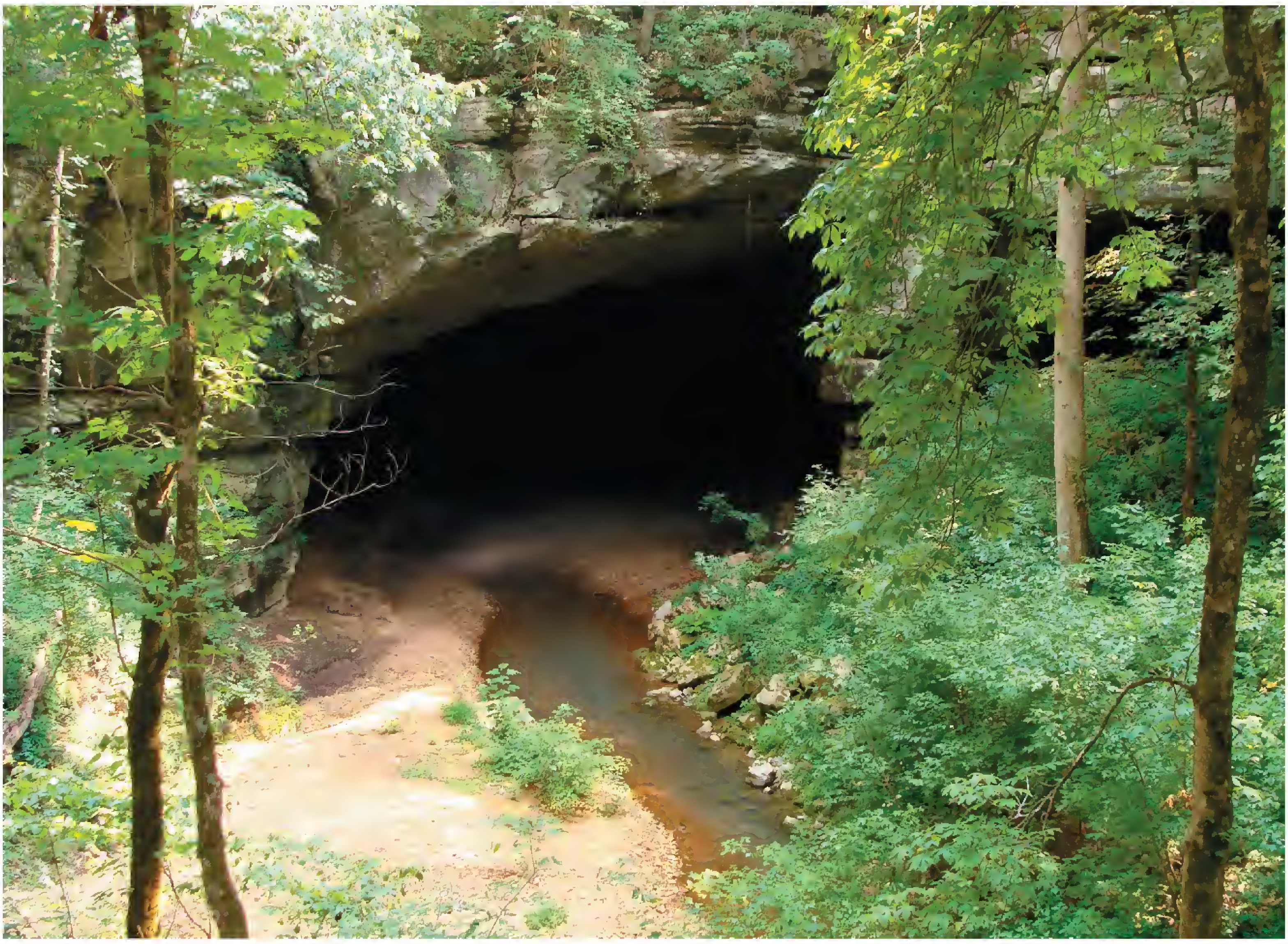

Fig. 1. Mouth of Russell Cave near the Tennessee border, Jackson County, Alabama.

cracking and grinding (Griffin 1974). Nuts likely utilized by Russell Cave inhabitants include hickories (*Carya*), oaks (*Quercus*), and black walnuts (*Juglans nigra*); available wild fruits were muscadines (*Vitis rotundifolia*), blackberries (*Rubus*), pawpaws (*Asimina*), maypops (*Passiflora incarnata*), and persimmons (*Diospyros virginiana*). Tubers of the American groundnut (*Apios americana*) may have been gathered as well (Heiser 1993) in this part of North America.

In early studies, Miller (1960) recovered a small basket with charred goosefoot (*Chenopodium*) seeds from Russell Cave. While its exact provenience is now under question, his find lends support for an Eastern Agricultural Complex that predates the arrival of established agricultural practices from Mesoamerica (see Smith 1985, 1989). Small grains such as goosefoot, marsh elder (*Iva*), and smartweed (*Polygonum*) might have been grown in plots, easing the transition to later, more intensive farming of the Three Sisters from Mesoamerica—corn (*Zea*), beans (*Phaseolus*), and various squashes (*Cucurbita*).

Caddell (1982) provides some evidence for an Eastern Agricultural Complex in Alabama. Using more modern techniques than those employed at Russell Cave, she analyzed the botanical remains from five sites in the Tombigbee River Valley of west-central Alabama. Hickory, oak, and walnut shells dominated most levels; the above-mentioned wild fruits were likewise apparent; and seeds of goosefoot, smartweed, amaranth (*Amaranthus*), canary grass (*Phalaris*), and many others were represented. Whether these latter seeds were gathered from the wild or grown in defined plots is, of course, unknown.

By the Mississipian Period (after 500 CE), the agricultural proficiencies of Alabama peoples were manifest in centers like Moundville along the floodplain of the Black Warrior River, which utilized the full complement of Mesoamerican foodstuffs. The influence of ancient Mexico upon Moundville is also revealed in its Aztec-like symbols and the building of temple mounds.

Although Mississippian culture, as at Moundville, disappeared by 1400 CE, many aspects remained. The annual Green Corn Ceremony has long been a part of Alabama life, celebrating the successful growth and harvest of this vital, sustaining grain. Most Southeastern tribes observed such ceremonies, continuing even after their Trail of Tears deportation to Oklahoma Territory (Swanton 1946; Hudson 1976).

Early European travelers and correspondents were also intrigued by a controversial ritual involving the Black Drink. The Creek Indians of Alabama and Georgia, especially, used the yaupon holly, *Ilex vomitoria*—one of the few Southeastern plants with a high caffeine content—in a dawn ritual that has generated many humorous anecdotes and some serious academic debate (Hudson 1979; Davenport 2003).

## EARLY EXPLORERS AND THEIR DESCRIPTIONS

Starting with Columbus' first voyage to the New World in 1492, Europeans focused on exploring that world and exploiting its riches. The first such explorer in the southeastern United States was Hernando de Soto (1500?–1542). De Soto's exact itinerary through Alabama is only roughly known, and the southwestern Alabama site ("Mabila") of his epic battle with the giant Chief Tascaluza (Black Warrior) is still being questioned (Badger & Clayton 1985; Hall 1987). But apparently De Soto *did* cross the Coosa River near Childersburg, whose sign boards ("The Oldest City in America") proclaim founding by him in 1540. Although four chroniclers recorded De Soto's travels across Alabama and the Southeast, they provide no real insights or descriptions of its vegetation.

The Spanish explorer Tristán de Luna (1519–1571) followed in 1560, restricting his incursion to the Alabama coastline; again, he left no real descriptions of specific plants and vegetation types that he saw. The French-Canadian colonist Pierre Le Moyne d'Iberville (1661–1706) landed at Dauphin (Massacre) Island, south of Mobile, in early 1699; there he discovered "all kinds of trees, oaks, elm, ash, pines, and other trees I do not know, many creepers, sweet-smelling violets, and other yellow flowers …" (McWilliams 1981). He and his younger brother, Jean-Baptiste Le Moyne de Bienville (1680–1767), established several outposts, including the current site of Mobile in 1711 (Atkins 1994).

The first trained naturalist to explore Alabama was William Bartram (1739–1823; Fig. 2). Bartram's *Travels* (1791) show that he entered the east-central part of the state in July 1775 by crossing the Chattahoochee River near Uchee in Russell County. (For naturalists, the preferred edition of Bartram's *Travels* is by Francis Harper [1958].) Continuing as part of a small caravan, he followed the Old Federal Road on horseback, in roughly a southwesterly direction. He was fascinated by "the plains" or Black Belt and included this very accurate description: "… [I]t lies on a deep bed of white, testaceous, limestone rock, which in some places resembles chalk, and in other places are strata or subterrene banks of various kinds of sea shells, … these dissolving near the surface of the earth, and mixing with the superficial mould, render[ing] it extremely productive." Bartram continued his overland trek to the edge of the Tensaw Delta northeast of Mobile, then crossed by boat to that city. He returned to the Delta and explored its northern reaches for several weeks, then finally set sail for his native Philadelphia.

Bartram's *Travels* (1791) provide us with the most vivid and accurate descriptions of primeval Alabama. Bartram's knowledge of Southeastern plant life, especially, was unsurpassed. However, his delay in publication "cost" him several important botanical species, which instead were described by others.

While exploring the Tensaw Delta during his final few weeks in Alabama, Bartram described three new species; two of these (*Myrica inodora* and *Magnolia pyramidata*) are still credited to him. He greeted a third one, *Oenothera grandiflora*, with his characteristic enthusiasm: "… [A] few miles above Taensa, I was struck with surprise at the appearance of a blooming plant, gilded with the richest golden yellow, … perhaps the most pompous and brilliant herbaceous plant yet known to exist." The seeds collected by Bartram that day became widely distributed in Europe, prompting Aiton (1789) to describe it from plants growing at Kew. The Dutch geneticist and co-re-discoverer of Mendelism, Hugo de Vries—due to its common occurrence and obvious mutagenicity—used it for his seminal studies on mutations (see Cleland 1935). The 1912 visit of De Vries to Bartram's "Taensa" (now Dixie Landing), to pay his respects at the type locality of *O. grandiflora*, is depicted by Davenport (2011).

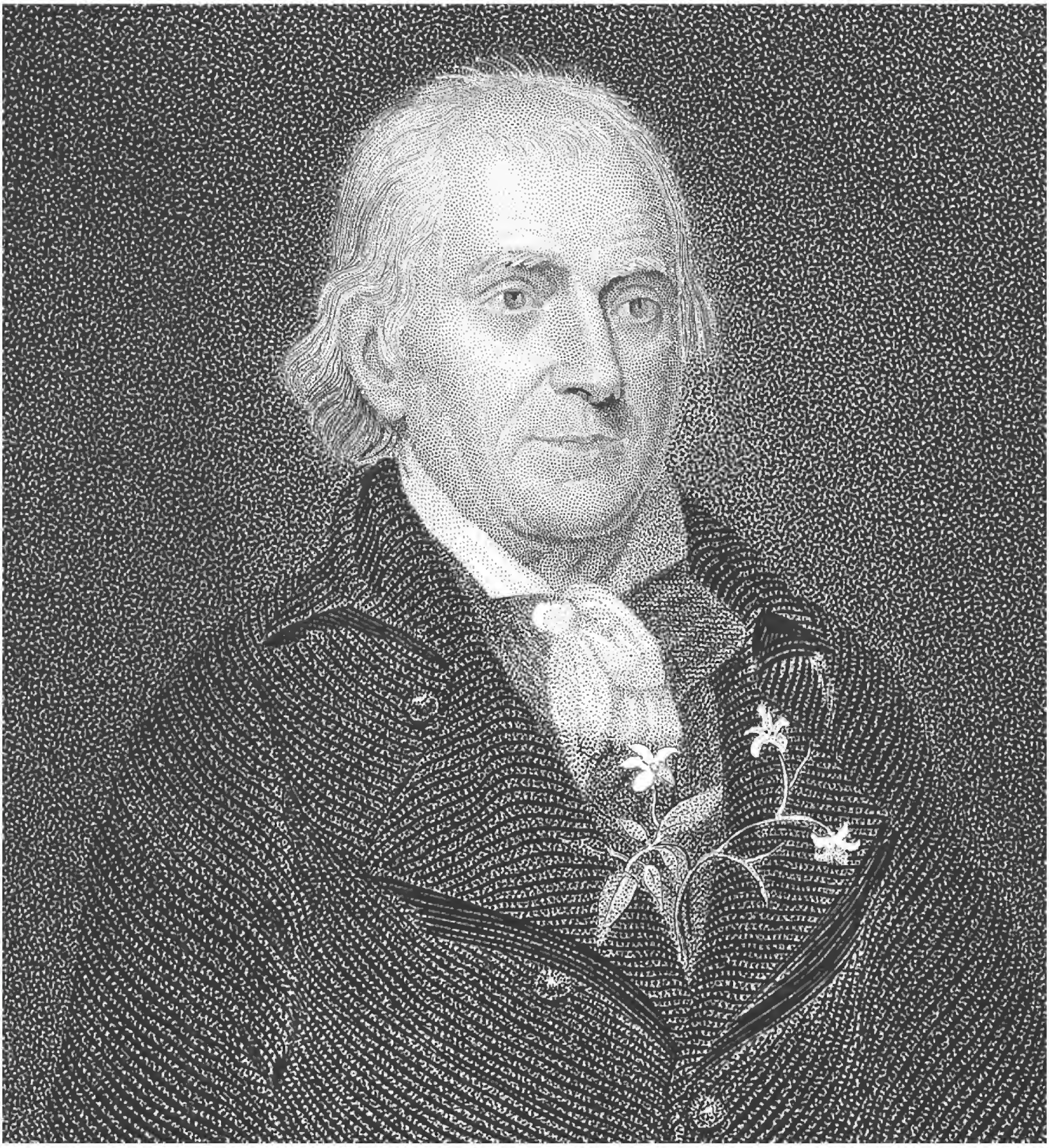

**Fig. 2. William Bartram. (Courtesy of the Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh, Pennsylvania).**

## PIONEERS, SETTLERS, AND TRAVELERS

The defeat of the Creek Indians at Horseshoe Bend of the Tallapoosa River in 1814 caused "Alabama fever" to sweep the young nation. Thousands of settlers converged on the land (then part of Mississippi Territory) subsequently ceded to the United States—rich bottomland forests and fertile Black Belt prairies, all connected by navigable waters to ship products worldwide. The land rush was on (for further details, see Atkins 1994).

Many early settlers entered Alabama via the Federal Road from the east, crossing the Chattahoochee and following Bartram's path toward Mobile, perhaps veering northwest to the rich Tombigbee Valley. Others ventured north from Mobile itself. A third group settled around Huntsville in the rich valleys of the Tennessee River drainage.

While few settlers described the countryside, several travelers did. Anne Newport Royall (1769–1854), traveling through and exploring northern Alabama from 1817–1822, published a volume of "letters" written to her friend "Matt" back in her native Virginia (Royall 1830). (Such letters, describing the people and places visited, were a popular literary device of that time.) Unlike other travelers' notes, Royall's letters contain a few descriptions of Alabama native plant life and habitats. Near Melton's Bluff on the Tennessee River (now inundated by 20th century dams), she encountered bottomlands with river cane "as thick as the hairs on your head"; higher up, "The land is so clear of undergrowth that you may drive a wagon any where through the woods." And she considered the area around Courtland (Lawrence County) as "the region of the Carolina pink [*Silene caroliniana*] and Colomba root [*Frasera caroliniensis*]. Wagonloads of the latter may be gathered any where in the woods; it, and the pink, cover the ground" (for other details of Royall's life and exploits, see Davenport [2014]).

During the 1830s, several British travelers took stagecoaches from Fort Mitchell (on the Chattahoochee) to Montgomery, then steamed down the Alabama River to Mobile, essentially following Bartram's route except by water; others took the same journey in reverse (Posey 1938). One such traveler was Scotsman James Stuart (1775–1849), who noted: "Since passing the Chattahoochee River, the beauty of the country, so far as respect trees and evergreens, has greatly increased. There are many splendid oaks, tulip-trees, chestnuts, and sycamores skirting the woods. The *Magnolia grandiflora* is found in great numbers, dog-wood, *Cornus florida*, and the red-bud, *Cercis Canadensis*, of great size, covered with a profusion of the most brilliant colours. …" South of Montgomery, "the stage passed through the first prairie land that I have seen, consisting of large undulating pastures, which seem never to have been covered with wood" (Stuart 1833).

Englishman James Silk Buckingham (1786–1855), traveling from Tuskegee to Montgomery, noted the following changes near Cubahatchee Creek: "The soil now became richer on each side, and the woods were much more variegated, as, besides the ever-succeeding pine, there was a thick underwood of various flowering shrubs and trees, including magnolias, yellow jessamines, the dogwood, and the grape-vine, with a very beautiful tree called the willow-oak" (Buckingham 1842).

A more "royal" traveler than Mrs. Royall and Messrs. Stuart and Buckingham was Sir Charles Lyell (1797–1875; Fig. 3). Scottish by birth and the premier geologist of that time, Lyell recorded his observations on the geology, natural history, and people of Alabama during his second trip to the United States. He and his wife left Columbus, Georgia, by stagecoach in late January 1846. Initially upset by the destruction observed in the newly cleared country, Lyell still waxed poetic: "The sound of the wind in the boughs of the long-leaved pines always reminded me of the waves breaking on a distant sea-shore, and it was agreeable to hear it swelling gradually, and then dying away, as the breeze rose and fell." At this early point in his visit, he also offered some less-than-poetic generalizations about the people he met: "As we go southward, we see more cases of intoxication, and hear more swearing" (Lyell 1849).

Continuing by railroad to Montgomery, Lyell got his first look at the Black Belt, "a broad zone of calcareous marl, constituting what is called the prairie, or cane-brake country, bare of natural wood, and where there is so great a want of water. …" His party then transferred to a steamboat for a long, winding trip to Mobile, and, continuing up the Tombigbee and Black Warrior rivers to Tuscaloosa, Lyell admired "the canes on the borders of the river …, some of which I found to be thirty feet high." Returning to Mobile, "on the banks of the Alabama river the deciduous cypress and cotton[wood] trees were putting out their leaves, and the beautiful scarlet seed-vessels of the red maple … enlivened the woods." And in the city itself, "for the first time, we saw the beautiful evergreen, the yellow jessamine (*Gelsemium sempervirens*), in full bloom …" (Lyell 1849).

The extensive canebrakes, dominating the alluvial lands of the state, mesmerized pioneers, settlers, and travelers alike. Their prehistoric extent in Alabama and the Southeast, importance to wildlife (such as bison and canebrake rattlers), conversion to agriculture, and consequent loss (perhaps 98%) have been summarized well by Platt and Brantley (1997) and Barone et al. (2008).

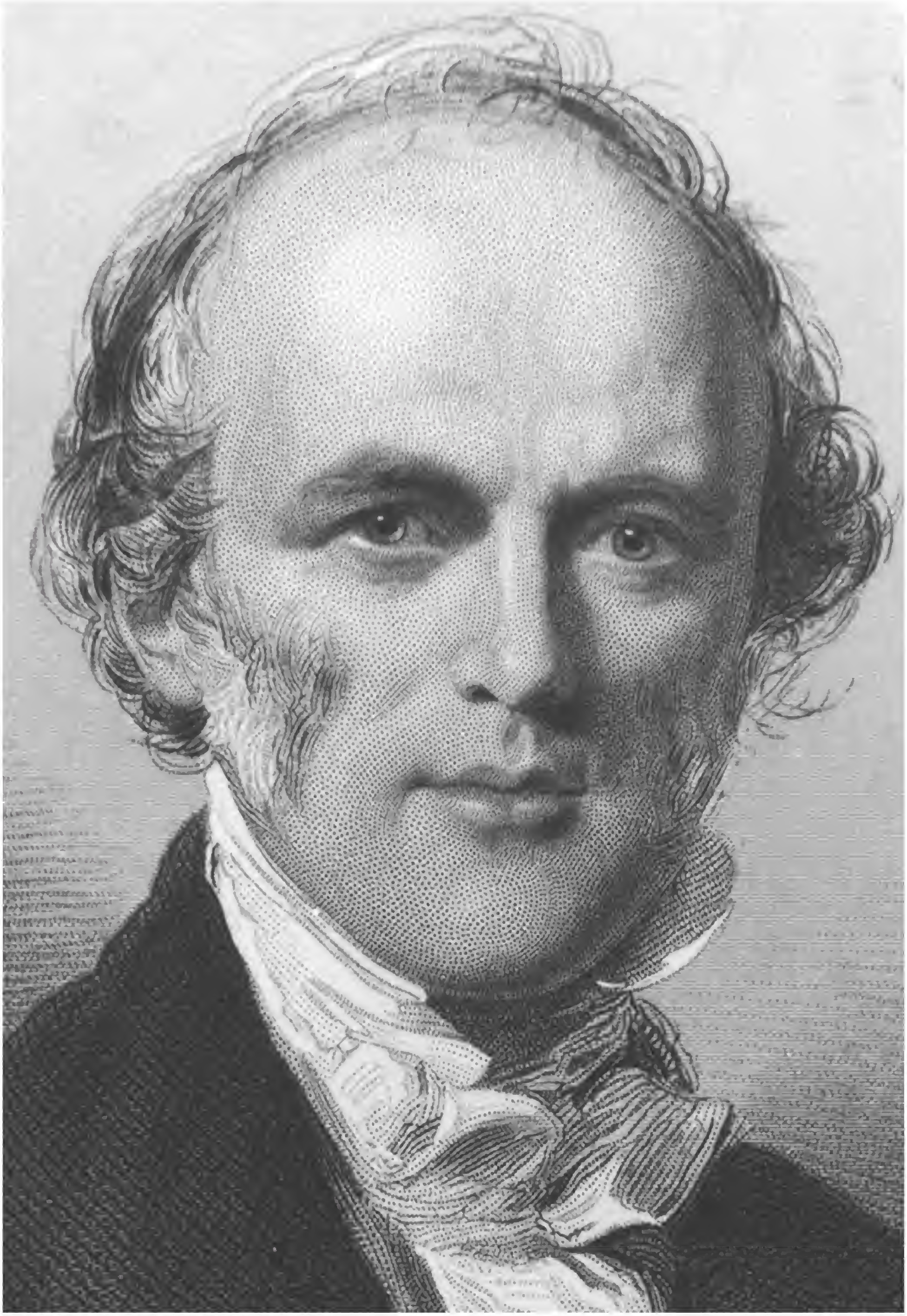

Fig. 3. Charles Lyell. (Courtesy of the Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh, Pennsylvania).

## EARLY TEACHERS AND ACADEMICS

Two itinerant teachers are essential to the story of the early days of Alabama natural history. The first, Englishman Philip Henry Gosse (1810–1888), arrived in Mobile during May 1838 and headed northeast toward Montgomery by steamboat to seek a teaching position. Along the way, he was hired by a Black Belt planter to teach in Pleasant Hill, southeast of Selma (Davenport 2010b).

Gosse spent just eight months in Alabama before returning to England. Over twenty years later, he used his copious notes and line drawings to publish *Letters from Alabama* (Gosse 1859). His exquisitely detailed water color paintings, long preserved by Gosse descendants, have recently been brought to light (Mullen & Littleton 2010).

Gosse's works are considered to be the first contributions by a trained naturalist residing (albeit briefly) in Alabama. Although Gosse was interested primarily in insects (especially butterflies), his works do include descriptions of host plants and key habitats.

A second resident/itinerant naturalist, Samuel Botsford Buckley (1809–1884), served as principal of the Allenton Academy (in Wilcox County) from 1839–40 (Anonymous 1907). Buckley was mainly interested in plant life, and, unlike Gosse, he published his findings soon after his sojourn in Alabama. In his first such paper, Buckley (1843) described four species that are currently included (Kral et al. 2011) in the Alabama plant list: *Phacelia purshii*, *Carex styloflexa*, *Diervilla sessilifolia*, and *Thalictrum debile*. Buckley left Alabama to return to his native New England, then passed through again in 1859 on his way to Texas, where he later served as State Geologist. (This was a time, in fact, when many Alabamians left the Old Southwest for the new one, often inscribing "Gone To Texas" or "GTT" on their cabin walls [Atkins 1994].) During this brief visit, he discovered *Quercus durandii* (Buckley 1860) "on the right hand side of the road, about three miles from Allenton" while walking home from Camden, the county seat (see also Buckley 1881 and Dorr & Nixon 1985).

Three resident academics also contributed to our early knowledge of Alabama's plant life. In the fall of 1853, Thomas P. Hatch (?–1855) was named Chair of Chemistry & Geology at LaGrange College, which was located on Little Mountain in northwest Alabama. In early 1855, the school moved across the Tennessee River, becoming Florence Wesleyan College and, much later, the University of North Alabama (see McDonald 1991). Hatch died that same year, soon after submitting a "floral calendar" to the *American Journal of Science and Arts* recording the blooming periods of local wildflowers (Hatch 1856). Many such calendars were kept during the 1850s, including one by nature philosopher Henry David Thoreau. They contain valuable data to support today's concerns about climate change (Nijhuis 2007; Miller-Rushing & Primack 2008).

The Rev. Dr. Reuben D. Nevius (1827–1913) served as rector of Christ Episcopal Church in Tuscaloosa during the 1850s and 1860s. During the spring of 1857, he and William Stokes Wyman (1830–1915), professor of Latin at (and later President of) the University of Alabama, discovered an unusual shrub along the Black Warrior River. Nevius (Fig. 4) sent specimens to Harvard's Asa Gray, who named it *Neviusia alabamensis* (Gray 1859) after one of its discoverers. (The naming of this new genus later became controversial, as depicted by Pollard [1900], Howard [1967], and Davenport [2000].) In that same paper, Gray described the succulent *Sedum nevii* in the reverend-doctor's honor.

In his introduction to *Plant Life of Alabama*, Mohr (1901) paid homage to his predecessor Dr. Hezekiah Gates (?–1849), "a successful apothecary at Mobile, [who] was the first collector of Alabama plants from the coast region, whence he contributed valuable material to Torrey and Gray for their Flora of North America, from the year 1836 to the early forties." Later in that same volume, Mohr named *Silphium gatesii* in his honor.

Little else is known about Dr. Gates, except that he died in a St. Louis, Missouri, cholera epidemic. The one-story Creole Plantation-style cottage that he built in 1841, now called the Gates-Daves House, still stands on Dauphin Street in Mobile.

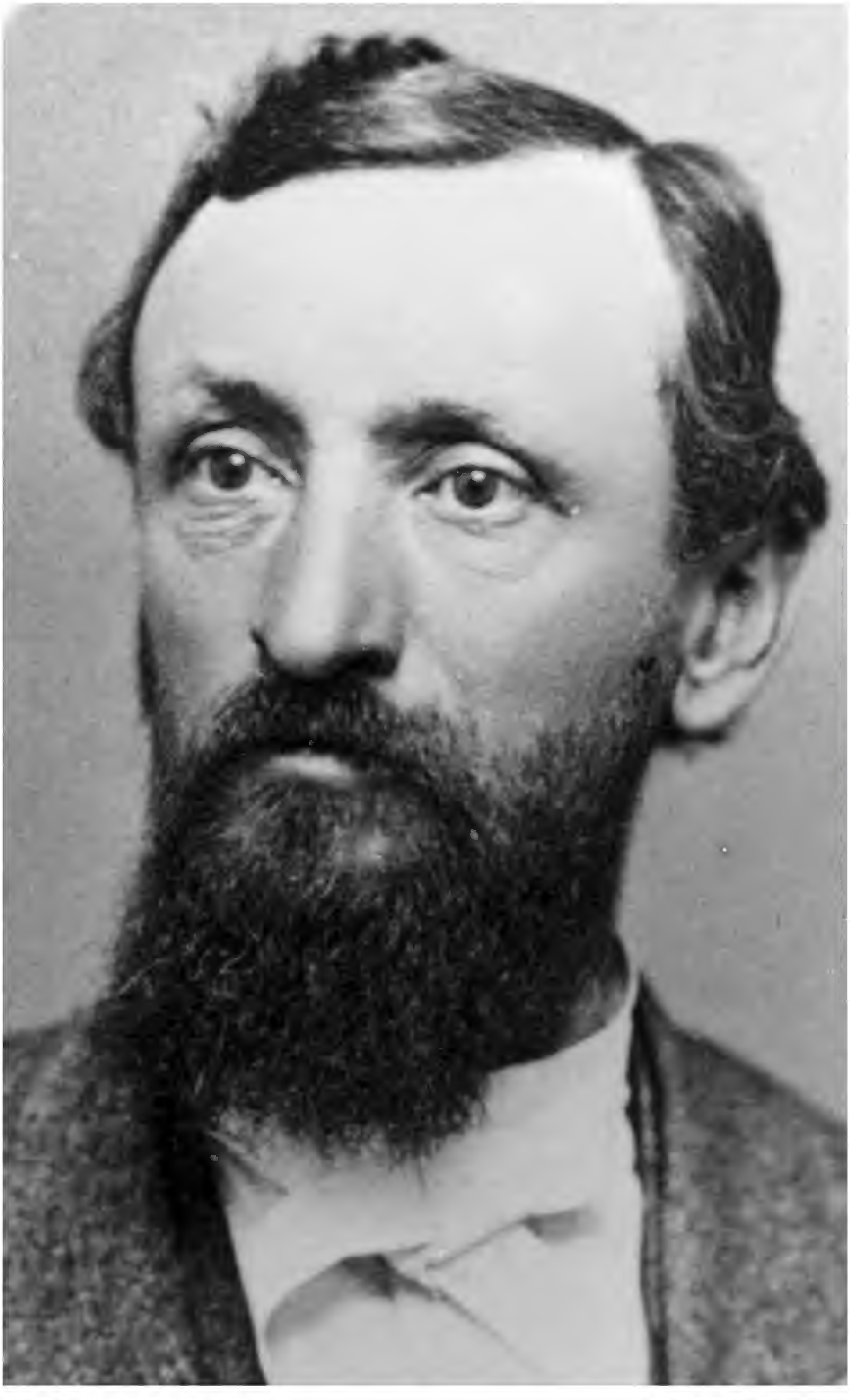

FIG. 4. Reuben D. Nevius. (Courtesy of the Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh, Pennsylvania).

## AN ANTEBELLUM HERBAL

On 1 December 1847, twenty-one physicians convened in Mobile to found the Medical Association of the State of Alabama (Holley 1982). One of the Association's first acts was to form a committee to study and report back on the uses of medicinal plants in their respective communities.

Such action was part of a national and regional trend. Similar reports had been published for the nation (Clapp 1852), South Carolina (Porcher 1849), and Louisiana (Hale 1852). In Alabama's case, the committee members' findings were published individually in the *Transactions of the Medical Association of the State of Alabama* from 1851–1855.

These reports differ in quality, quantity, and scientific value. Some authors show solid foundation in the botanical sciences by following a systematic format, like that of Linnaeus (Smythe 1851), De Jussieu (Denny 1851; Bates 1853), Torrey and Gray (Cabell 1855), or "according to the natural order" (Jenkins 1854). One (Clanton 1855) is an obvious copy of an earlier one; another (Batchelor 1853) concentrates on just one species, *Gelsemium sempervirens*. While most describe the plants and their uses quite fully, Welch (1851) provides few details. Two years after, Denny (1853) offered an apology for his earlier publication and a plea that "a universal Congress of Scientific men" will soon "effectually disperse the great clouds of synonyms"—something still hoped for today. And Smith (1852) included a botanical joke: *Aletris aurea* "Berry much" resembles the previously mentioned *A. farinosa*.

Combined together, these ten publications by nine authors constitute an antebellum herbal, describing medical treatments based on 241 species. No other sources record the medicinal use of plants—native, naturalized, and cultivated—in central Alabama at that time.

## 1860–1900

One of the most complete and useful of the above treatments of Alabama's medicinal plants was by Prattville, Alabama, physician Samuel Parrish Smith (1814–1891), mentioned above. His son, Eugene Allen Smith (1841–1927), studied geology in Germany after the Civil War, and after completing his Ph.D., he was first appointed Assistant State Geologist of Mississippi and then State Geologist of Alabama, based in Tuscaloosa. He served in the latter capacity from 1873 until his death.

As part of his duties in his native state, Smith undertook long summer forays to examine and describe Alabama's geology and, especially, its mineral resources. Along the way, he collected plant specimens. By 1878 he had collected enough unusual species to warrant help from an expert, so he turned to Mobile pharmacist Charles Mohr (1824–1901; Fig. 5).

Born Karl Teodor Mohr in Würtemburg, Germany, Mohr trained mainly in chemistry (for Mohr's life story, see Smith 1901; Davenport 1979a, 1979b). With the revolutionary waves of 1848, he immigrated to the United States, followed the Gold Rush to California, married a woman from the German community of Cincinnati, and moved to Mexico. Seeking a healthier climate, politically and otherwise, he settled in Mobile, Alabama, in 1860, where he established a successful pharmaceutical business.

Mohr's interest in Alabama plants, combined with Smith's curiosity about the state's resources, formed a long and fruitful collaboration. The first "fruit" was a checklist of Alabama's known plant life (Mohr 1880); the final one was the 921-page *Plant Life of Alabama* (Mohr 1901), published jointly by the U.S. National Herbarium and the Geological Survey of Alabama. The latter remains, to this day, as the only "complete" flora of the state.

Oddly, the first potential collaboration between Smith and Mohr was deferred to Apalachicola, Florida, physician-botanist Alvan Wentworth Chapman (1809–1899). Smith had collected an unknown shrub with *Elaeagnus*-like leaves along the Cahaba River north of Centreville in central Alabama (for more details on this story, see Davenport 1994 and Wurdack 2006). Mohr sent the specimens on to Chapman, who described *Croton alabamensis* in the second edition of his *Flora of the Southern United States* (Chapman 1887).

In the twenty years prior to *Plant Life*, Mohr published extensively on Alabama's flora. He was especially interested in new species (Mohr 1897, 1899), adventives on Mobile Bay's ballast grounds (Mohr 1878), medicinal plants (1890), and forest trees (Mohr 1882, 1883, 1896a).

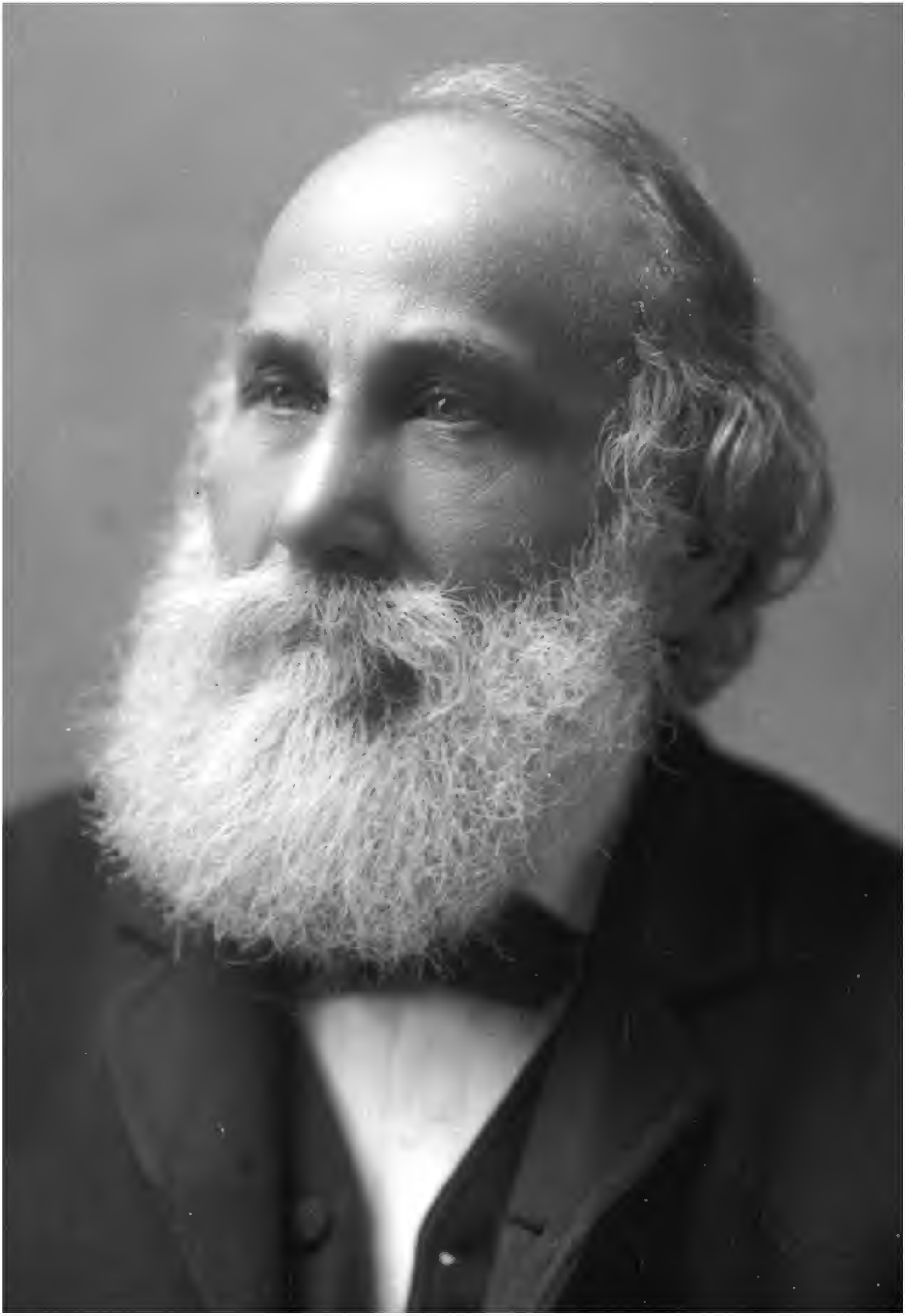

Fig. 5. Charles T. Mohr. (Courtesy of Erik Overbey/Mobile Public Library Collection, University of South Alabama Photographic Archives, Mobile, Alabama).

Another sidelight was Mohr's relationship with Patrick H. Mell (1850–1918), botanist at the Agricultural & Mechanical College of Alabama (now Auburn University). After corresponding with Mohr about some identifications, Mell (1896a) published Part V of his own *Flora of Alabama*, covering the legume and rose families (Parts I–IV never appeared). Mohr was shocked, and the American botanical community—which knew of Mohr's many years of work on Alabama's plants—called for Mell's censure (Anonymous 1896). Despite his plea of innocence (Mell 1896b), Mell retired from Alabama botanical battles. Mohr (1896b), in a letter to E.A. Smith, vowed to treat the entire Mell Affair with "silent contempt" and renewed his efforts to finish his opus (for a light-hearted, football-themed depiction of this episode, see Davenport [2010a]).

Mohr was the first person to consider the overall picture of Alabama's vegetation. In the introductory pages of *Plant Life*, he combined climate factors and average temperatures (basic to Merriam's Life Zones) to divide the state into two nearly equal halves—the northern, temperate, Carolinian Area and the southern, tropical, Louisianan Area (Fig. 6). He then subdivided these areas based on soil, substrate, and other characteristics, describing the plant associations within each one.

Mohr's comrades include Judge Thomas Minott Peters (1808–1888) of Moulton (Lawrence County) in north-central Alabama. Trained as an attorney, Peters (Fig. 7) served as Chief Justice of Alabama's Supreme Court after the Civil War. Before that war, he pursued his avocation of botany, particularly lichens and fungi, sharing much information with Moses A. Curtis and Henry William Ravenel (Haygood 1987). Gray (1853) described the rare fern *Trichomanes petersii* from specimens collected by Peters in Hancock (now Winston) County. Mohr (1901) was grateful enough to Peters for his contributions on nonvascular plants that he included a short biographical sketch of Peters in *Plant Life*. Significantly, the Alabama Edition of that book includes only two portraits, those of Mohr and Peters (for more on Peters, see Davenport [2014]).

In *Plant Life of Alabama*, Mohr (1901) also mentioned the vital contributions of Lucien Marcus Underwood (1853–1907) and Franklin Sumner Earle (1856–1929) to his knowledge (and lists) of the state's fungi, lichens, and bryophytes. Underwood, a colleague of Mell at the Agricultural & Mechanical College, was also one of the first professional botanists to visit the Havana Glen (Hale County) hybrid *Asplenium* site (see Underwood 1896). Underwood left Auburn for Columbia University and was replaced by Earle, who contributed greatly to *Plant Life* in the areas of fungi and lichens (Hansen 2003a, 2003b). One year after that publication, Earle (1902) published a flora of the Alabama Piedmont.

## 1900–1960

The two decades surrounding the new century featured "incursions" by several botanists from the Biltmore Herbarium. This herbarium, established in Asheville, North Carolina, sent out teams to comb the Appalachian Mountains and their environs for new and unusual species (for a history of the Biltmore Herbarium and its activities and accomplishments, see Anderson [2007]).

The contributions of this group to Alabama botany are numerous, especially in descriptions of new species of forest trees—although most of them are now sunk in synonymy (Davenport 2015). Chauncey D. Beadle (1866–1950) was particularly prolific for Alabama trees, giving us *Quercus boyntonii* (Beadle 1901b) and many "new" hawthorns (Beadle 1901a, 1902a) and cherries (Beadle 1902b). Beadle and Boynton (1901) also described the rare composite *Marshallia mohrii,* naming it for Charles Mohr, who moved to Asheville to consult the Biltmore Herbarium and complete work on *Plant Life of Alabama*. (Sadly, Mohr died two weeks before his book was published; hence, he is buried in Asheville rather than in his long-time home, Mobile.) Thomas Grant Harbison (1862–1936) contributed *Trillium stamineum* (Harbison 1901) and *T. decumbens* (Harbison 1902b), plus general descriptions of the Alabama flora (Harbison 1902a).

Roland McMillan Harper (1878–1966) arrived in Tuscaloosa during late 1905 to begin a seven-decade-long association with the Geological Survey of Alabama. He commemorated the event, in typical Harper fashion, by taking a long stroll or "ramble" and noting the plant associations that he saw (Harper 1906).

A Northerner by birth, Harper (Fig. 8) moved south with his school superintendent father and family, graduating from the University of Georgia before pursuing his doctorate at Columbia University. For his dissertation, Harper studied the Altamaha Grit region of his adopted state, confirming the connection between

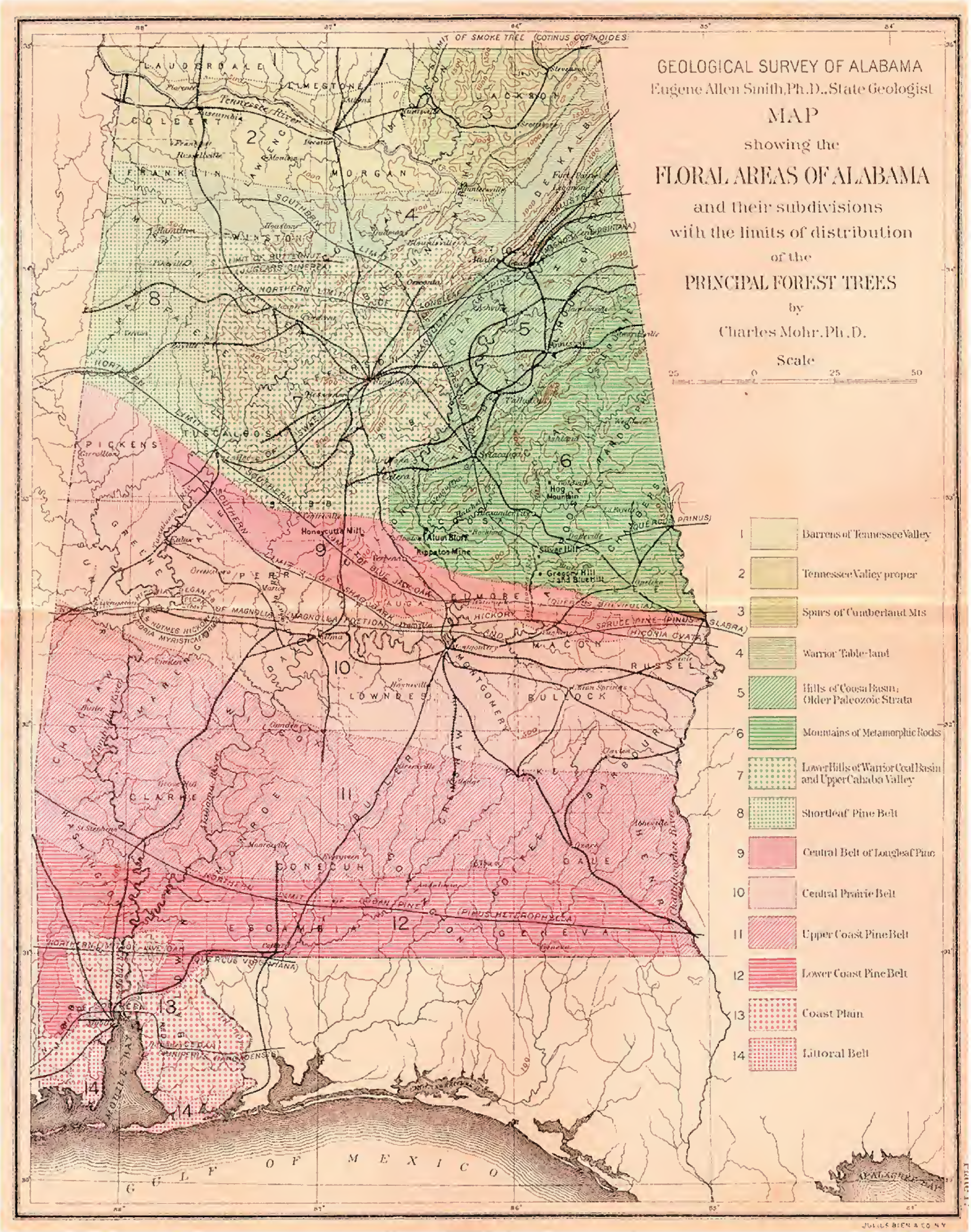
GEOLOGICAL SURVEY OF ALABAMA
Eugene Allen Smith, Ph.D., State Geologist
MAP
showing the
FLORAL AREAS OF ALABAMA
and their subdivisions
with the limits of distribution
of the
PRINCIPAL FOREST TREES
by
Charles Mohr, Ph.D.
Scale
25 0 25 50
1 Barrens of Tennessee Valley
2 Tennessee Valley proper
3 Spurs of Cumberland Mts
4 Warrior Table-land
5 Hills of Coosa Basin; Older Paleozoic Strata
6 Mountains of Metamorphic Rocks
7 Lower Hills of Warrior Coal Basin and Upper Cahaba Valley
8 Shortleaf Pine Belt
9 Central Belt of Longleaf Pine
10 Central Prairie Belt
11 Upper Coast Pine Belt
12 Lower Coast Pine Belt
13 Coast Plain
14 Littoral Belt
GULF OF MEXICO
JULIUS BIEN & CO. N.Y.

Fig. 6. Map of the Floral Areas of Alabama from frontispiece of Mohr's *Plant Life of Alabama* (Alabama Edition).

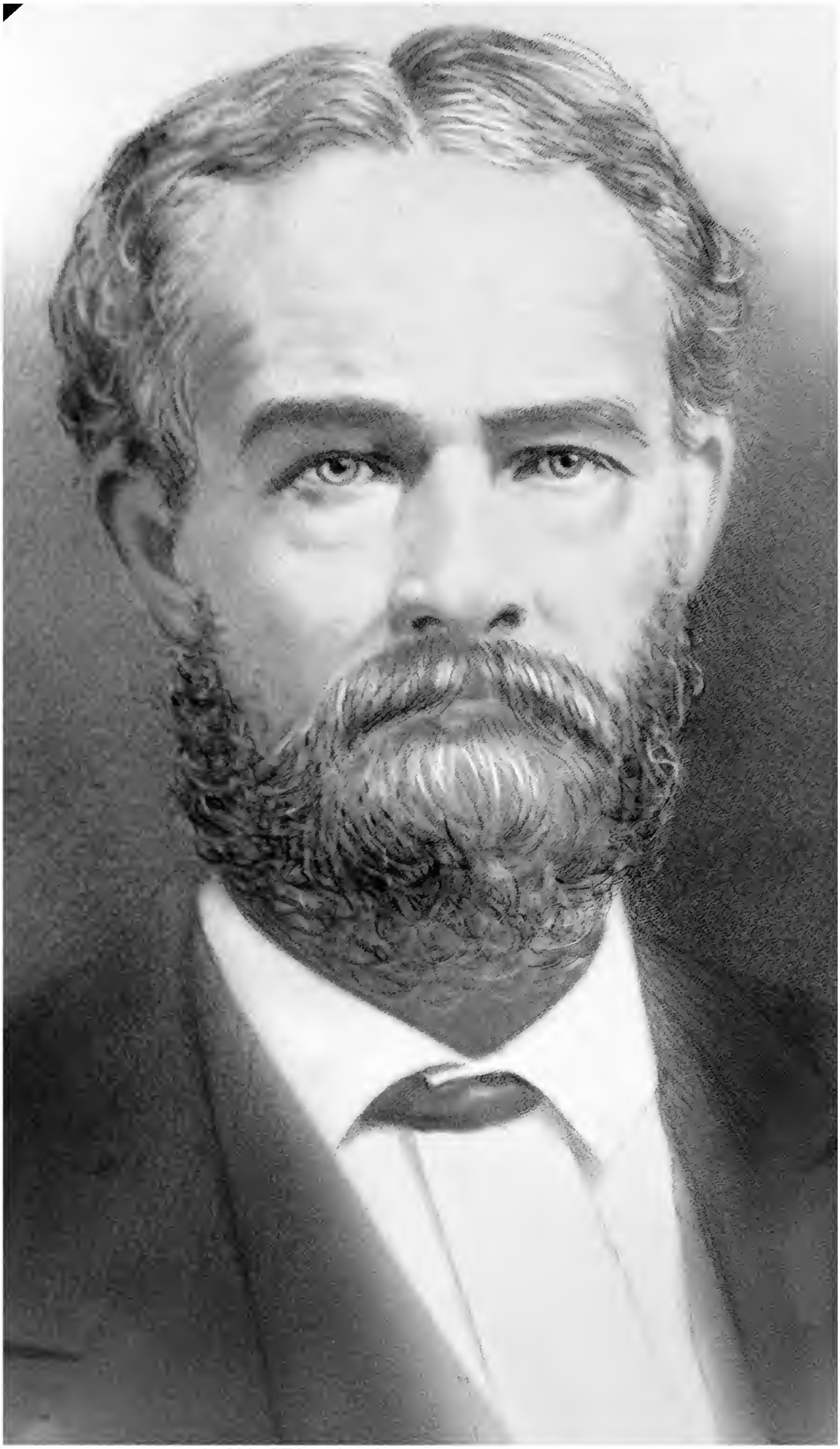

Fig. 7. Thomas Minott Peters. (Courtesy of the Alabama Supreme Court and State Law Library, Montgomery, Alabama).

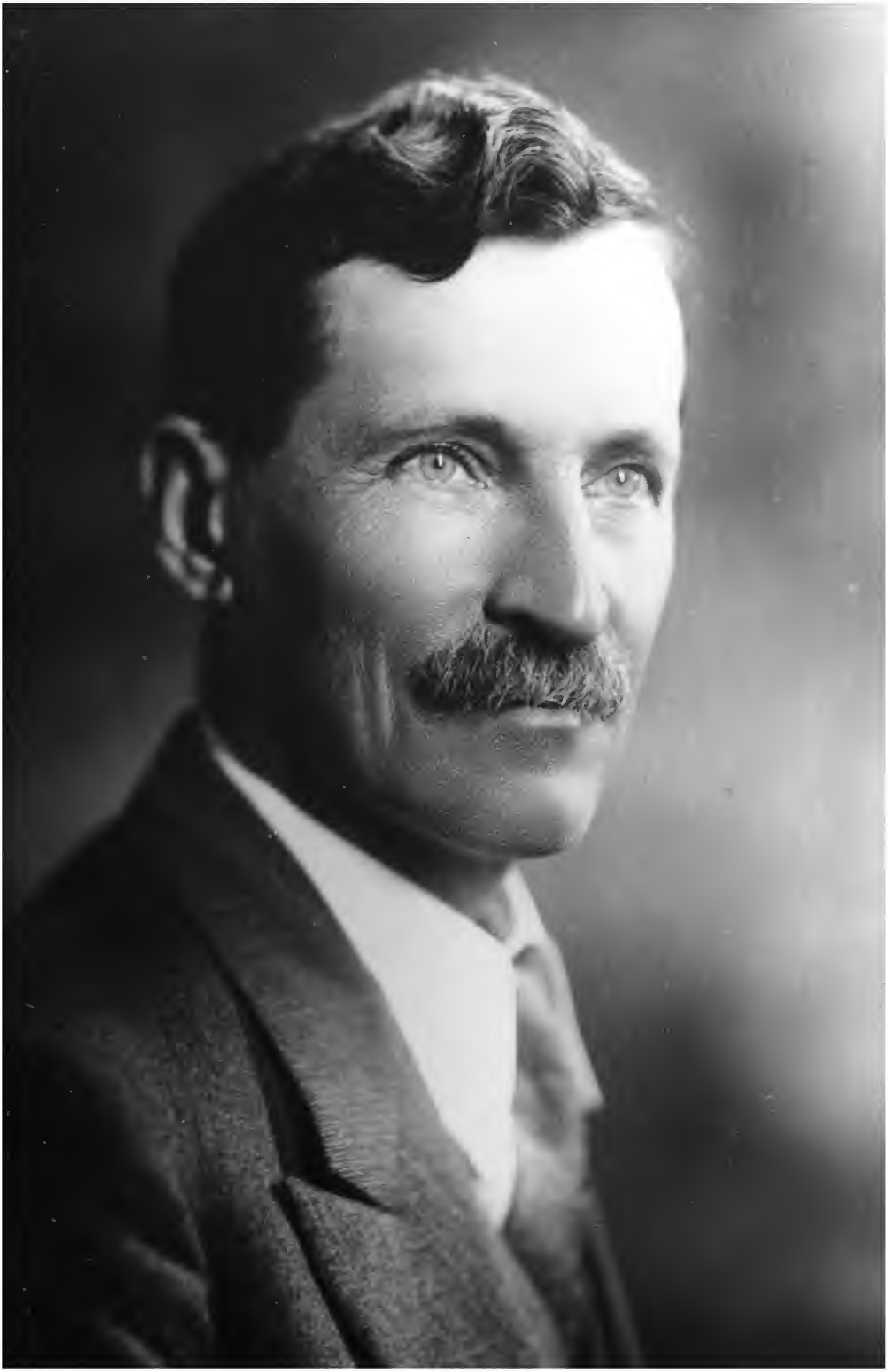

FIG. 8. Roland McMillan Harper. (Courtesy of the Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh, Pennsylvania).

geology and plants—a theme that he would pursue throughout his life. He was then hired by E.A. Smith "to continue the work of the late Charles Mohr" on the economic plants of Alabama (Harper 1967). Except for short stints in Georgia and Florida, Harper remained connected to the Geological Survey of Alabama until his death.

During his long and storied career, Harper published over 600 individual papers. (His life and works have been summarized by Davenport and Hubbs [1995].) While many of these are impassioned letters-to-the-editor and statistical "proofs" of societal trends, the rest are legitimately scientific. (An independent spirit, Harper never published with a co-author.) Harper's main botanical themes were "plant sociology" or community composition (which he often recorded from train car windows), descriptions of new species (which he often deferred to others), and the need for fire "un"suppression to maintain Southeastern forests.

Prodigious in memory and tireless in ambulation (since he never learned to drive an automobile), Harper pursued the most distant and rarest of plants. He produced many works dealing with Alabama's plant communities (Harper 1914, 1937, 1939) and newly discovered species, such as *Hexastylis speciosa* (Harper 1936). His largest and most Mohr-like works are a series of monographs for the Geological Survey on economic plants, forest resources, and weeds (Harper 1913, 1928, 1942, 1943a, 1944).

In *Forests of Alabama*, Harper (1943a) greatly revised Mohr's 1901 system of plant associations, placing his emphasis on geological formations rather than on climate. He concluded that "a map of [Alabama's] forest regions does not differ much in its broader features from a geological map." Harper's forest regions and subregions (Fig. 9), based primarily on geology and soils, are nearly identical to those recently designated by Griffith et al. (2001) and described above.

There's a famous story about Harper and his cross-country effort to meet up with Professor de Vries at the type locality of *Oenothera grandiflora*, in southern Alabama. De Vries was on a cross-country tour to Houston, Texas, to deliver an honorary address at Rice University. (This celebratory trip was similar to that of Lyell seventy years before.) He was feted wherever he went, including Tuscaloosa on 21 September 1912, where he and H.H. Bartlett of the U.S. Department of Agriculture were met at the railroad station by State Geologist Smith and by Harper. The next day, the first three gentlemen set out by train and steamboat for Dixie Landing on the Alabama River in Baldwin County, where Bartram had discovered *O. grandiflora* in 1775. Harper preferred to rough it, and he and a colleague set out by train and on foot, camping out in the rain. They arrived in time to meet the De Vries party retracing Bartram's voyage up the Mobile Delta. Oddly, Harper—who recorded most of the details of his adult life in a series of diaries—wrote nothing about meeting the world's most famous geneticist (Shores 2008; Davenport 2011).

Harper was far friendlier toward the Benedictine monk Wolfgang Wolf (1872–1950; Fig. 10) of Saint Bernard Abbey in Cullman; in fact, in her biography of Harper, Shores (2008) devoted an entire chapter to these "Kindred Spirits." The pair met in 1927, shortly after the death of E.A. Smith. By that time, Wolf (1918) had already published the hybrid oak *Quercus bernardiensis* (*Q. montana* × *Q. stellata*); his final publication (Wolf 1945) was of another oak hybrid, *Q. capesii* (*Q. nigra* × *Q. phellos*). More significantly, he described *Talinum mengesii* (Wolf 1920), naming it after his abbot at Saint Bernard (see Plaisance 1958), and later *T. appalachianum* (Wolf 1939). He also created the genus *Cryptophila* (Monotropaceae), which he separated from *Monotropsis* (Wolf 1922).

In many ways, Wolf and Harper collaborated on studies of *Erythronium* in the 1930s, trading information and specimens (Shores 2008). But rather than a joint paper, the two published separate ones (Harper 1941; Wolf 1941) in back-to-back issues of *Castanea*. It was Harper (1951) who announced Brother Wolfgang's death to the botanical community.

## SWAMP, PRAIRIE, HEMLOCK, AND GLADE STUDIES

The Tennessee Valley Authority (TVA) was established in 1933. During the 1930s and 1940s, several Alabama ecological studies were conducted by individuals who were either then or formerly employed by TVA. In keeping with TVA interests, these studies (Penfound & Hall 1939; Hall & Penfound 1943; Penfound et al. 1945) dealt largely with swamp and mosquito issues. In addition, Isely (1946) published a treatment of aquatic plants found in TVA reservoirs, later updated by Dennis et al. (1977).

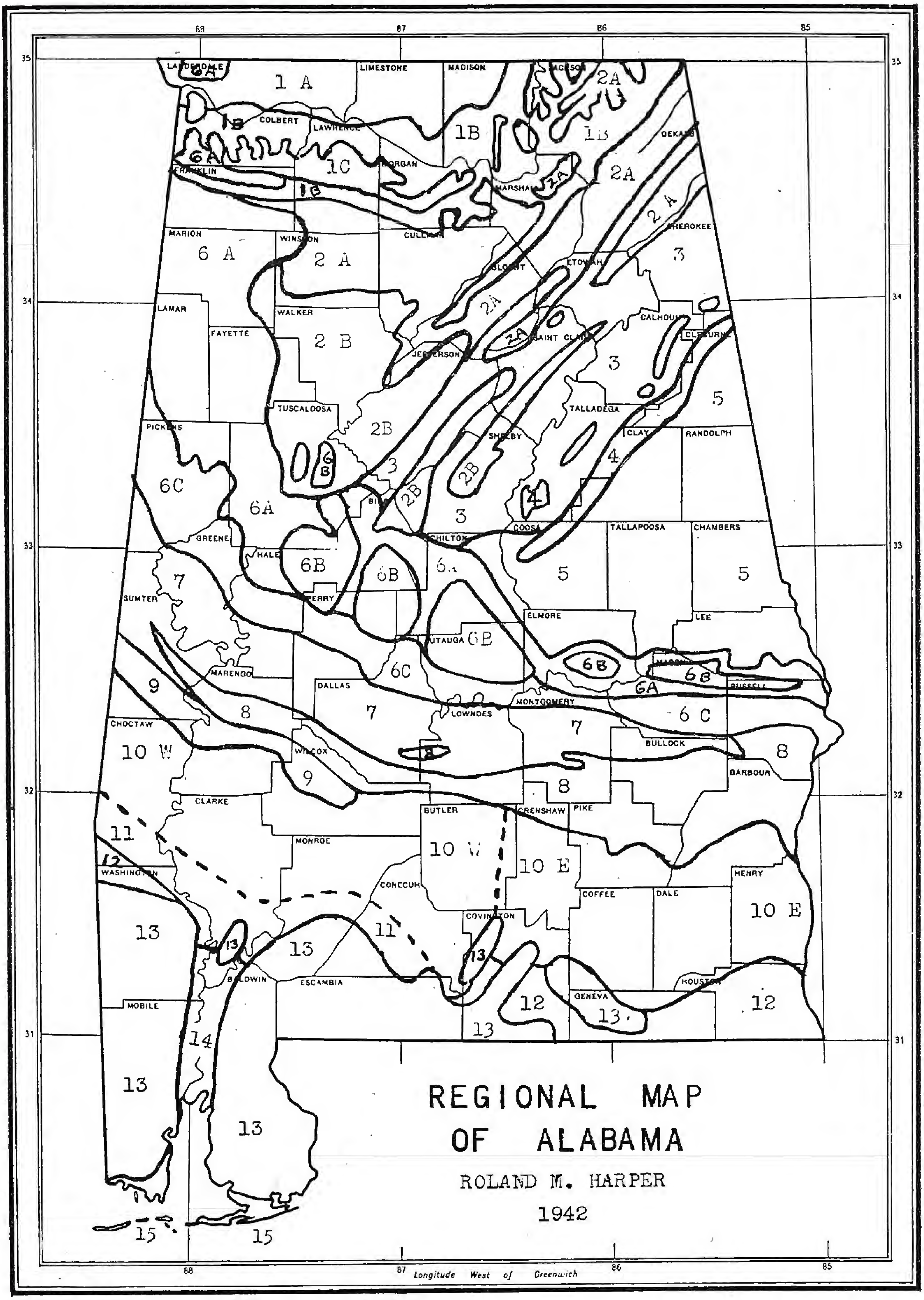
REGIONAL MAP
OF ALABAMA
ROLAND M. HARPER
1942
Longitude West of Greenwich
88
87
86
85
35
34
33
32
31
LAUDERDALE
LIMESTONE
MADISON
JACKSON
COLBERT
LAWRENCE
MORGAN
MARSHALL
DEKALB
FRANKLIN
CHEROKEE
MARION
WINSTON
CULLMAN
BLOUNT
ETOWAH
CALHOUN
CLEBURNE
LAMAR
FAYETTE
WALKER
JEFFERSON
SAINT CLAIR
TALLADEGA
TUSCALOOSA
PICKENS
SHELBY
CLAY
RANDOLPH
BIBB
COOSA
TALLAPOOSA
CHAMBERS
GREENE
HALE
CHILTON
SUMTER
PERRY
ELMORE
LEE
AUTAUGA
MACON
RUSSELL
MARENGO
DALLAS
MONTGOMERY
LOWNDES
BULLOCK
CHOCTAW
WILCOX
BARBOUR
CLARKE
BUTLER
CRENSHAW
PIKE
MONROE
WASHINGTON
CONECUH
COFFEE
DALE
HENRY
COVINGTON
HOUSTON
BALDWIN
ESCAMBIA
GENEVA
MOBILE
1 A
1 B
1 C
2 A
2 B
3
4
5
6 A
6 B
6 C
7
8
9
10 W
10 E
11
12
13
14
15

FIG. 9. Regional Map of Alabama, based largely on geology, from Harper's *Forests of Alabama*.

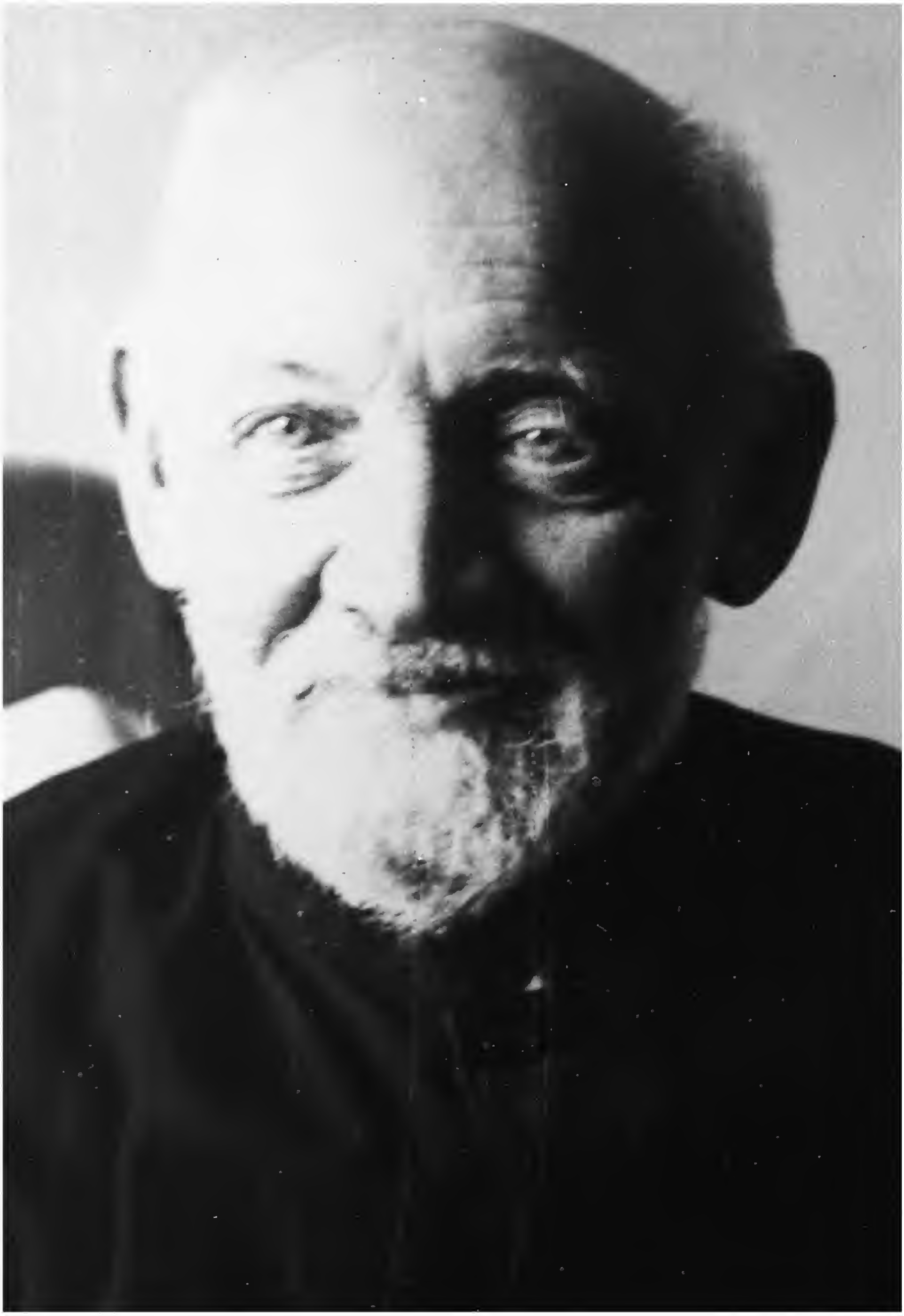

Fig. 10. Wolfgang Wolf. (Courtesy of Auburn University Special Collections and Archives, Auburn, Alabama).

As shown above, travelers have long been fascinated by the Blackland Prairie or Black Belt of central Alabama; and one early resident (McGuire 1834) demonstrated solid understanding of its origin. Since the 1920s, many studies have built on those initial observations, including ones by Harper (1920), Cocks (1925), Jones and Patton (1966), Rankin and Davis (1971), Schuster and McDaniel (1973), and Barone and Hill (2007).

A second fascination has been the presence of Canadian hemlock in Alabama's Southwestern Appalachian Ecoregion. Hemlock studies include those by Harper (1943b), Segars et al. (1951), and Hardin and Lewis (1980).

Working out of Vanderbilt University and the University of Kentucky, Jerry and Carol (Caudle) Baskin published extensively on cedar glades and their endemics, including several from Alabama (Baskin & Baskin 1976, 1984, 1986a, 1986b; Baskin & Caudle 1967; Baskin et al. 1995; Webb et al. 1992). A later paper (Webb et al. 1997) listed the species known from the glades and barrens of northwestern Alabama.

Another limestone-based endemic first noted in northwest Alabama, *Jamesianthus alabamensis*, was described by S.F. Blake and E.E. Sherff (Sherff 1940) from specimens supplied by Harper. For details of its discovery and naming, see Harper (1943b), Baldwin (1969), and Dennis (1982).

### HALE COUNTY AND OTHER FERN STUDIES

No more famous botanical site exists in west-central Alabama than Havana Glen in Hale County. The site first came to light thanks to the efforts of Julia S. Tutwiler (1841–1916; Fig. 11). In 1873, Tutwiler—also noted as a prison reformer, founding president of the Livingston Normal College (now the University of West Alabama), and writer of the state anthem—discovered an odd fern in the Glen and recognized it as a hybrid *Asplenium* (for more on this story, see Davenport [2007]). The site was later visited and described by Underwood (1896) and Wherry and Trudell (1930). Because chromosome studies by Wagner (1954) revealed that the hybrid is a viable, self-reproducing tetraploid, the plant was recently re-named *Asplenium tutwilerae* (Keener & Davenport 2007).

Summary works on Alabama's ferns came much later. John W. Short studied the state's fern flora for his Master's thesis at Auburn University (Short 1978) and published several related papers (Short & Freeman 1978a, 1978b; Short 1979). Daniel D. Spaulding joined forces with several other authors to cover the northeastern portion of the state (Spaulding et al. 2000a, 2000b, 2001a, 2001b, 2001c). Alvin R. Diamond, Jr. and Michael Woods did the same for the southeastern portion (Diamond & Woods 2007; Woods & Diamond 2008). Very recently, Short and Spaulding (2012) produced the definitive fern guide for Alabama.

### BRYOPHYTE AND LICHEN STUDIES

In order to provide a nearly complete floral treatment, Mohr (1901) included non-vascular plants in his *Plant Life of Alabama*. Since that time, few Alabama bryophyte papers have been published. Harvill (1950) described *Diphyscium cumberlandianum* from King Cove in southwestern Lawrence County; he also supplied a list of moss species (including new state records) found in that same "remarkable cove" (Harvill 1951). Wilkes (1965) published a checklist of Alabama mosses; Bowers et al. (1989a, 1989b), Davison and Schotz (1998), and Diamond et al. (1999) have added many species to that list.

Mohr (1901) also included lichens in his flora, thanks mainly to the efforts of Auburn University's F.S. Earle. A century later, Hansen (2003b) updated that catalog and provided a detailed list of lichen collectors and publications.

## 1950–2011

The last half of the twentieth century was dominated by floristic studies in Alabama. This emphasis on floristics was part of a state-wide resurgence in natural history led by key individuals at state universities, plus one very determined amateur.

That amateur was Blanche Evans Dean (1892–1974; Fig. 12). A native of Goodwater (Clay County), Dean taught science courses at Woodlawn High School in Birmingham (for details of Dean's life, see Christenson and Davenport [1997]). But her main love was out-of-doors, specifically nature study. In 1951 she began a series

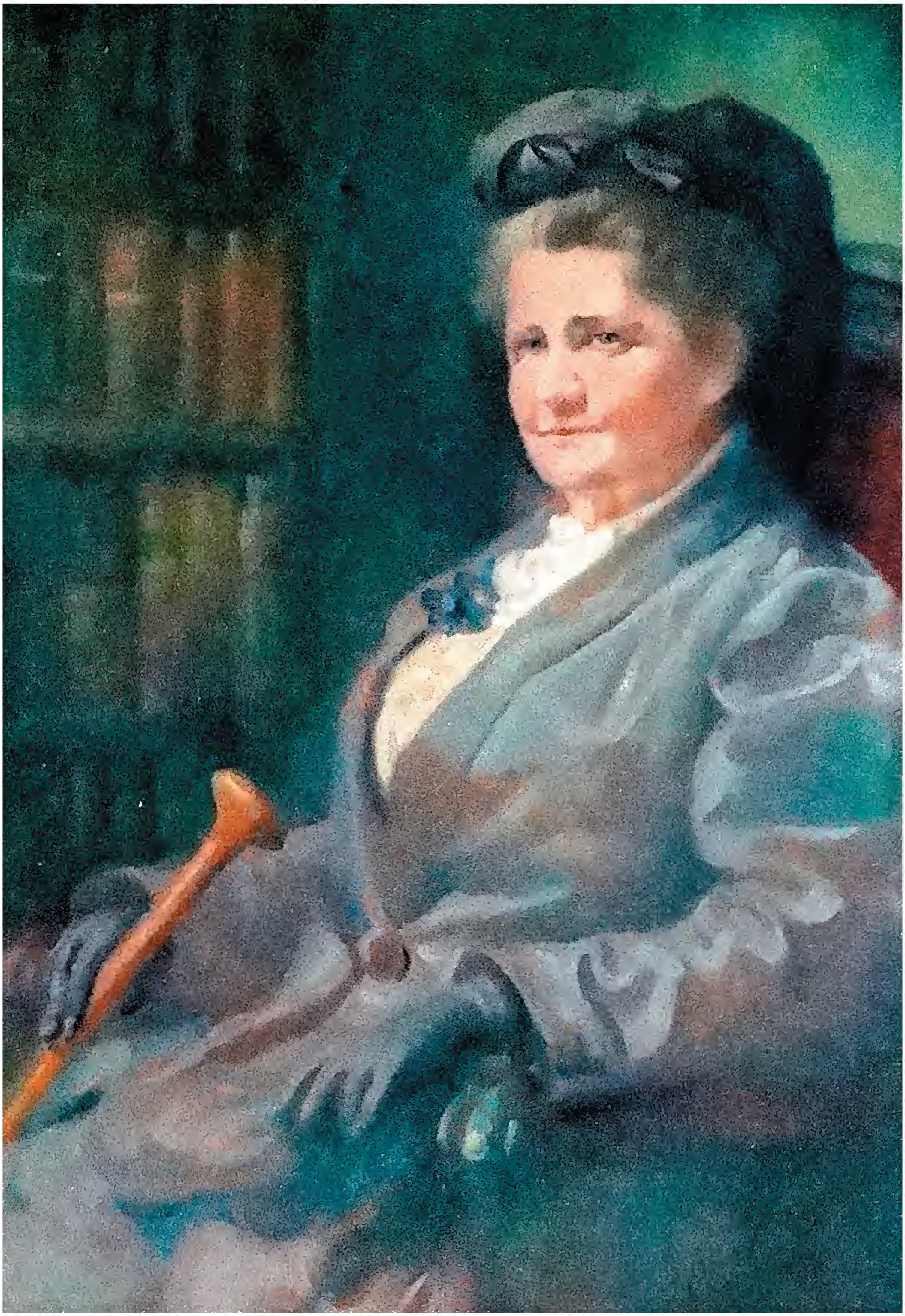

**Fig. 11.** Julia S. Tutwiler. (Courtesy of Julia Tutwiler Library, University of West Alabama, Livingston, Alabama).

of Outdoor Nature Camps, which morphed into the Audubon Mountain Workshops held at Mentone (DeKalb County) each spring (for a history of the camps and workshops, see Holliman [1984]). She consolidated her knowledge of Alabama's plant life into books on trees, ferns, and wildflowers (Dean 1961, 1969; Dean et al. 1973).

At the University of Alabama, a resurgence of nature study was led by Ralph L. Chermock (1918–1977) following World War II (see Davenport 2011). An American-born nephew of the Austrian geneticist Erich von Tchermak (as in Tchermak, Correns and De Vries, the re-discoverers of Mendelism), Chermock mainly mentored zoology students. (The most famous Chermockian of all is Harvard University's E.O. Wilson; see Wilson [1994] for his reminiscences.) As part of this natural history emphasis, Stallard (1950) produced a floristic study of the Fort Morgan Peninsula under the direction of Chermock's colleague, A.M. Harvill, Jr. (1916–2008), who has been mentioned previously for his bryological contributions.

In the 1960s, Joab L. Thomas (1933–2014; Fig. 13) and his students engaged in studies of Alabama endemics, like *Croton alabamensis* (Farmer 1962; Farmer & Thomas 1969) and *Neviusia alabamensis* (Thomas & Deramus 1964). They also characterized the Black Belt flora (Maginness 1967; Naugle 1967) and that of Tanglewood Field Station (Williams 1967), Holt Lock and Dam (Brooks 1969), and Dauphin Island (Deramus 1970).

Thomas left Alabama to become Chancellor of North Carolina State University, later returning to the University of Alabama as its president. His botanical successor, Robert R. Haynes, conducted a series of studies on Alabama's aquatic vascular plants (Haynes 1980; Davenport & Haynes 1981; Wiersema & Haynes 1983; Haynes & Jacono 2000). In addition, Wiersema (1979) examined the distribution of the Nymphaeaceae in the state; Hendryx (1996) focused on the aquatic and wetland plants of the Oakmulgee Division of Talladega National Forest; and Keener (1999) studied the flora of Blount County.

With the 1968 arrival of John D. Freeman (1941–1997; Fig. 14), botanical interest at Auburn University was significantly rekindled (Hansen 2003a). Under the direction of Freeman and others, students completed many floras and ecological studies, including Reed Brake Research Natural Area (Beckett 1980; Beckett & Golden 1982), the Red Hills (Diamond 1987), Conecuh County (Diamond & Freeman 1993), Black Belt river bluffs (Gunn 1985), the Tombigbee River (Crouch 1997; Crouch & Golden 1997), montane longleaf pine communities (Maceina 1997; Maceina et al. 2000), Horseshoe Bend National Military Park (Petranka et al. 1979), the Piedmont Plateau (Rutland 1977), the Cahaba River (Sessler 1978), and Alabama's trees and shrubs (Younghance & Freeman 1996).

Botanists at Auburn University and the University of Alabama collaborated on a listing of the state's endangered, threatened, and special concern plants (Freeman et al. 1979). Such a list was an expansion of that proposed by Thomas (1976).

Freeman's Auburn colleague, Robert S. Boyd, has concentrated on plant ecological studies, especially those involving rare species: *Clematis socialis* (Boyd & Hilton 1994), *Xyris tennesseensis* (Boyd et al. 2011), and *Rudbeckia auriculata* (Diamond et al. (2006).

During the 1990s, the rapidly growing plant collections at the University of Alabama and Auburn University were databased; the data were then combined into a single checklist (Morton et al. 2002). Many of the "gaps" in that list were filled by adding specimens from the universities listed below.

Thanks to his dissertation work at the University of North Carolina, Ross C. Clark contributed much to our understanding of Alabama's woody plants (Clark 1967, 1969, 1971). Another UNC doctoral student, R. David Whetstone, concentrated on the flora of the Cumberland Plateau of our state (Whetstone 1981).

Whetstone then resumed residence at his alma mater, Jacksonville State University. His many students completed county-wide or local floras, including the following: Talladega Ranger District (Ballard 1995), Jefferson County (Barber 1986), Jackson County (Brodeur 1999), Cheaha State Park (Bussey 1983), Little River Canyon (Dickson 1992), Etowah County (Hodge-Spaulding 1997), Limestone County (Hofmann 2000), Horseblock Mountain (Hruska 1997), Dugger Mountain (Hutchinson 1998), St. Clair County (Jackson 2000), Randolph County (Nixon 1989), Lake Guntersville State Park (Spaulding 1995, 1999a, 1999b), Madison County (Threlkeld 1998), and Choccolocco Creek (Weninegar 2002).

At the University of South Alabama, Michel G. Lelong intensively studied the flora of the Outer Coastal

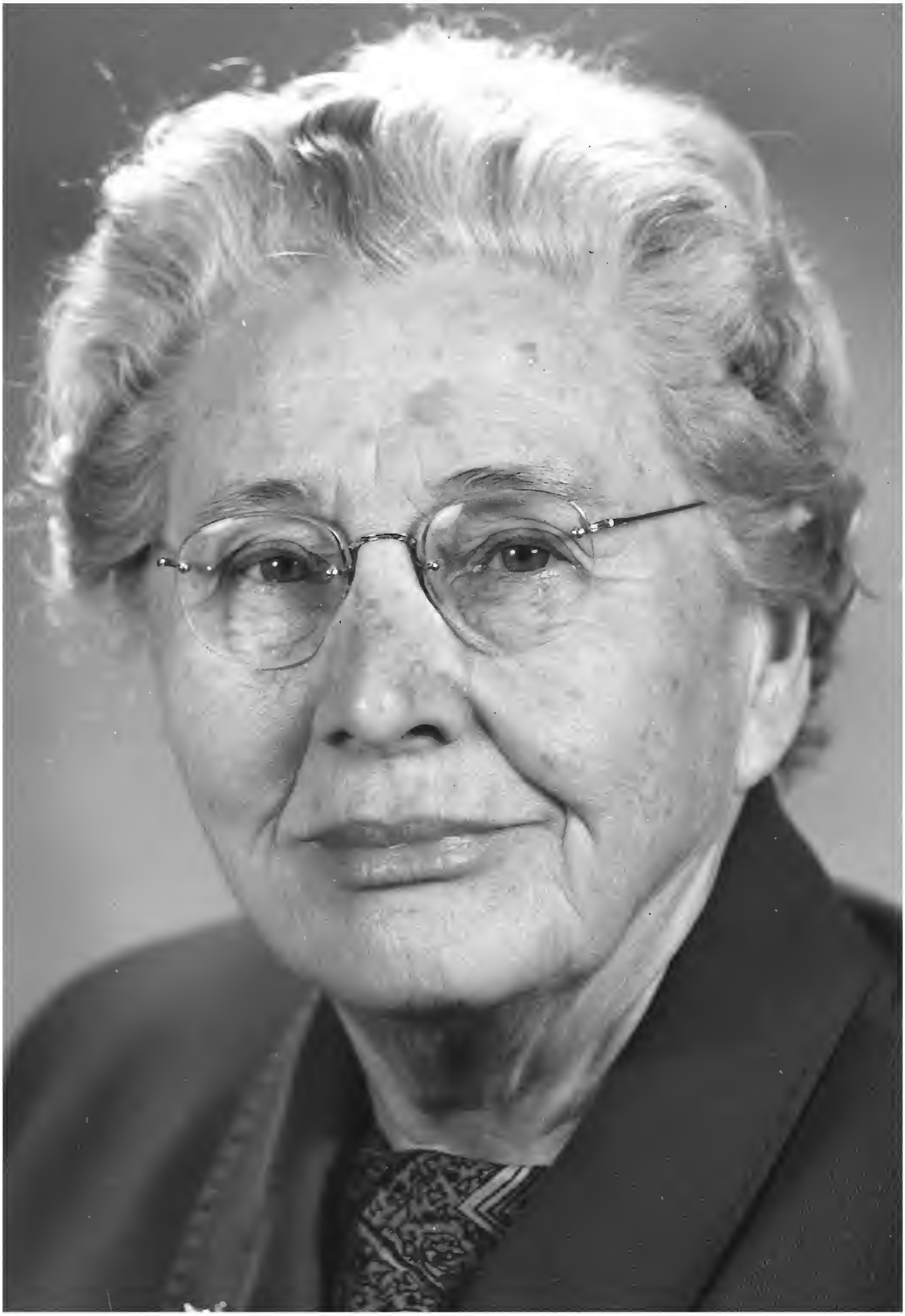

Fig. 12. Blanche Evans Dean. (Courtesy of the Alabama Women's Hall of Fame, Judson College, Marion, Alabama).

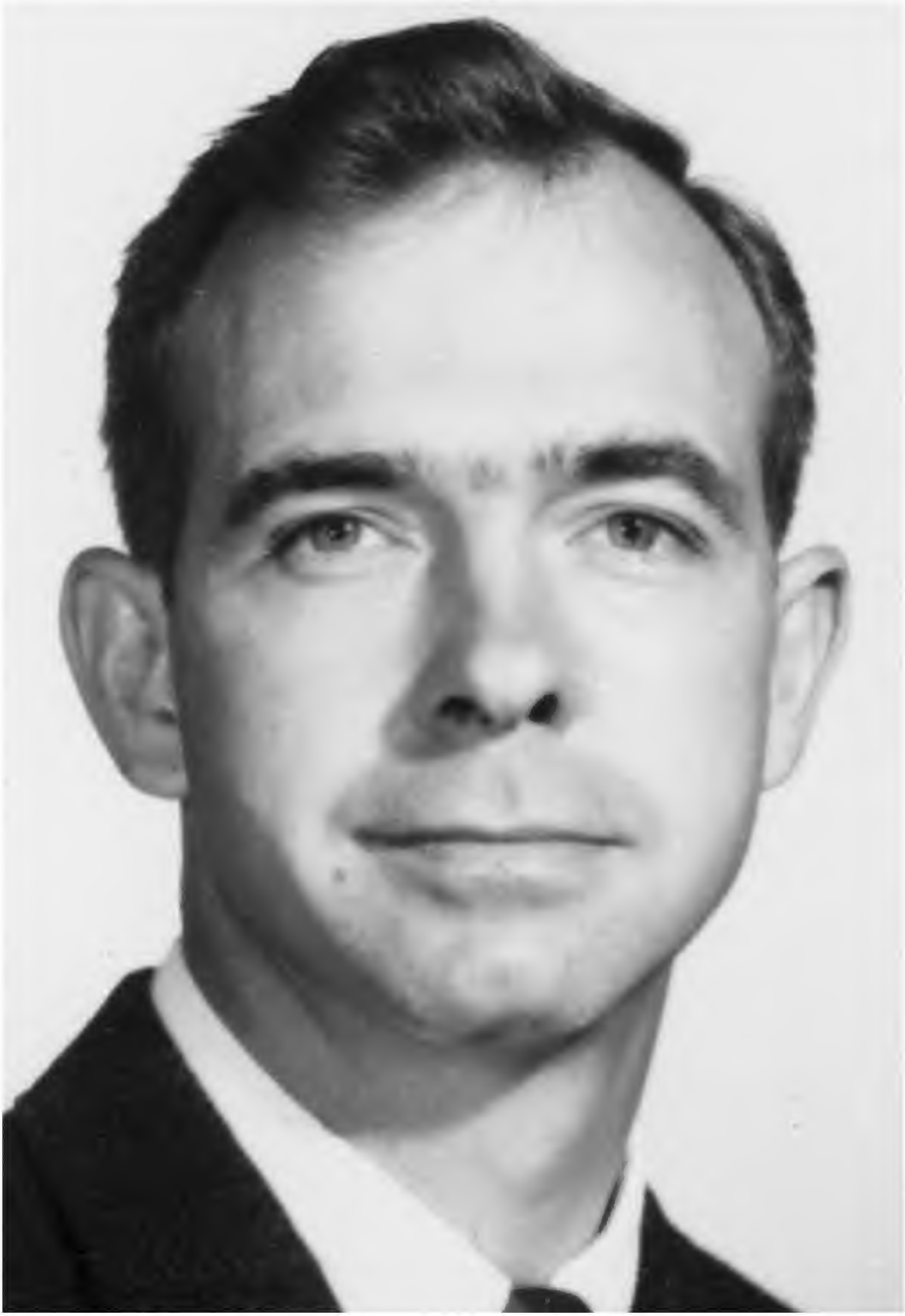

Fig. 13. Joab L. Thomas. (Courtesy of the Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh, Pennsylvania).

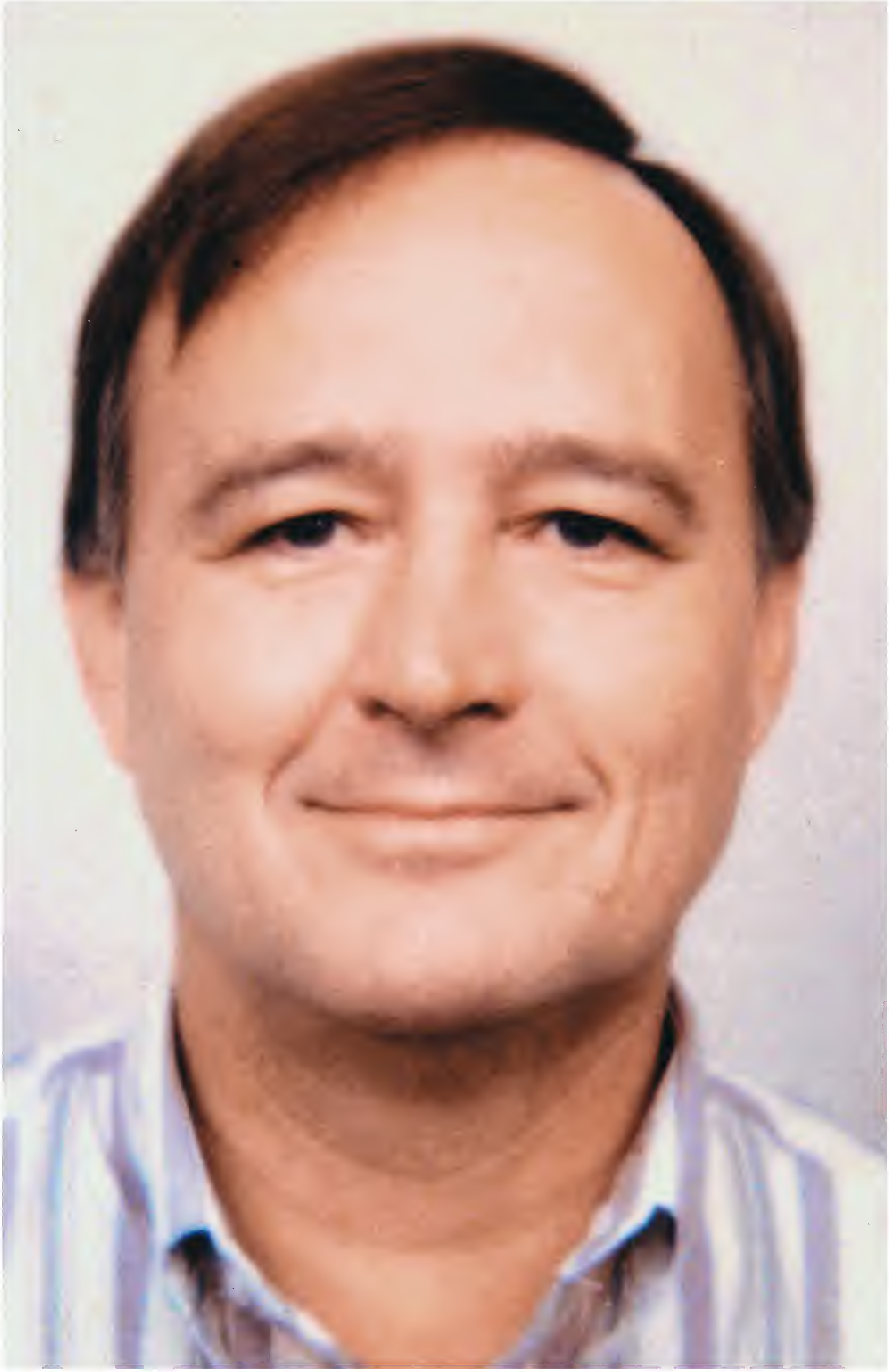

FIG. 14. John D. Freeman. (Courtesy of the Freeman family, Auburn, Alabama).

Plain. He published several works on the general flora and the rare plants of Baldwin and Mobile counties (Lelong 1977, 1988a, 1988b, 1991).

The work of Michael Woods and Alvin Diamond have put Troy University's botany program securely on the Alabama map. Woods has directed several legume studies (Woods 2008; Woods & Key 2009), while he, Diamond, and their students have produced many floras: Pike County (Diamond 2003), Crenshaw County (Diamond 2011), Pike County Pocosin Nature Preserve (Diamond et al. 2002), Dale County (Dransfield & Woods 2004), Coffee County (Martin 2001; Martin et al. 2002), Ech Lake (Rundell & Woods 2001), Pike County Lake (Woods & Reiss 1998), and Dale County Lake (Woods et al. 2000). In addition to their work on ferns listed above, Woods and Diamond (2005) collaborated on a treatment of southeastern Alabama gymnosperms.

Several other theses have been produced by students from out-of-state universities. These schools include the Catholic University of America (Morgan 1942, Cullman County); the University of North Carolina (Bostick 1964, 1967; St. Clair County); and Mississippi State University (McDearman 1976, Lawrence County; Smith 1996, Marion County).

Alabama's Forever Wild Land Trust was established by constitutional amendment in 1992; since that time, over 200,000 acres of land—including some of the state's most pristine—have been purchased for the public trust. T. Wayne Barger, botanist with the State Lands Division (which oversees the program), has directed several studies of these vital Forever Wild properties, including Indian Mountain (Barger & Holt 2010) and Coon Creek (Barger & Tenaglia 2008).

The end of the twentieth century also marked a return to herbal studies. John K. Crellin and Jane Philpott documented the herbal treatments prescribed by Alabama's leading modern folk practitioner, A. L. "Tommie" Bass (1908–1996) of Leesburg (Cherokee County). Throughout his long career, Bass combined frontier, Native American, and African-American traditions. The two-volume set (Crellin & Philpott 1989, 1990) very accurately records his extensive knowledge, country charm, and wit.

### JIM ALLISON'S LOST WORLD

In the early 1990s, Georgia botanist James R. Allison discovered a "lost world" in Bibb County, Alabama, with several rare and new taxa inhabiting the severe, exposed landscapes of Ketona dolomite there (Allison & Stevens 2001). The new taxa included *Castilleja kraliana, Coreopsis grandiflora* var. *inclinata, Dalea cahaba, Erigeron strigosus* var. *dolomiticola, Liatris oligocephala, Onosmodium decipiens, Silphium glutinosum,* and *Spigelia gentianoides* var. *alabamensis* (now elevated to species status; see Weakley et al. 2011). In addition, seven state records were discovered, including *Solanum pumilum*, which was presumed extinct.

These dolomitic glades are rightly considered "one of the most significant reservoirs of botanical diversity in the eastern United States" (Allison & Stevens 2001). One of the largest is now preserved as the Kathy Stiles Freeland Bibb County Glades by the Nature Conservancy.

### ROBERT KRAL

But it is the work of Robert Kral that dominates Alabama botany today. Based at Vanderbilt University and funded by the National Science Foundation, Kral (Fig. 15) undertook intensive study of the flora of the Southeast, starting in the 1960s. And thanks to several travel grants from the USDA Forest Service, he produced the massive, two-volume, 1305-page *A Report on Some Rare, Threatened, or Endangered Forest-Related Vascular Plants of the South* (Kral 1983a, b). Kral's intention has always been to produce a flora of Middle Tennessee (the section directly north of Alabama) and Alabama itself. Toward this end, he published a series of papers on the rarities that he encountered (Kral 1973, 1976a, 1981).

Kral has always taken on the toughest taxonomic assignments, including *Xyris* (Kral 1966a); Eriocaulaceae (1966b); *Rhexia* (Kral & Bostick 1969); *Abildgaardia, Bulbostylis,* and *Fimbristylis* (Kral 1971); and *Fuirena* (Kral 1978a). He has produced many treatments of the above groups for the *Flora of North America* and various floras of Central and South America. And he has described many new species, including the following from Alabama: *Delphinium alabamicum* (Kral 1976b), *Xyris tennesseensis* (Kral 1978b), *Sagittaria secundifolia* (Kral

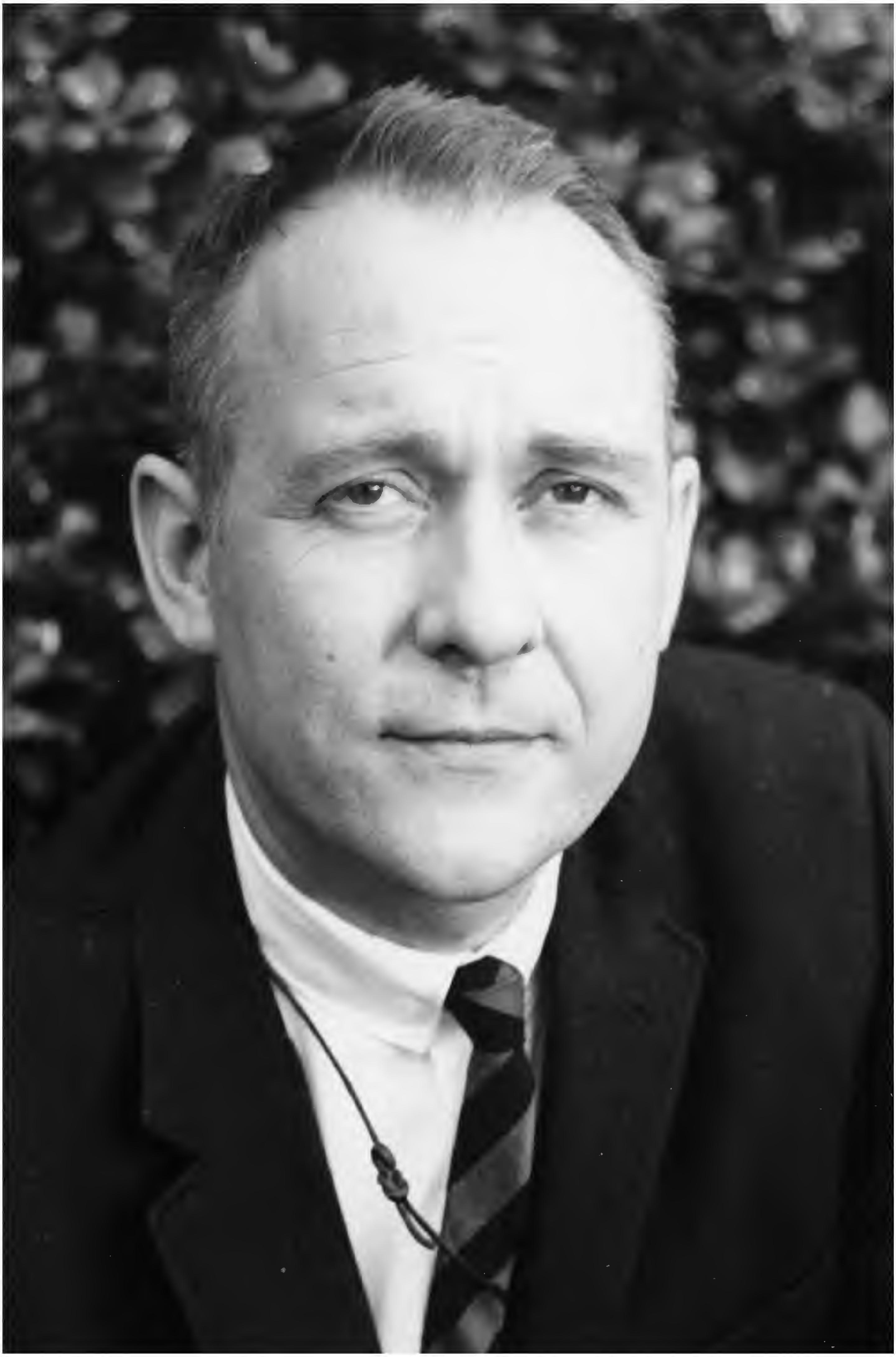

Fig. 15. Robert Kral. (Courtesy of the Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh, Pennsylvania. Photograph by Walter Henricks Hodge.).

1982a), *Clematis socialis* (Kral 1982b), *C. morefieldii* (Kral 1987), *Fimbristylis brevivaginata* (Kral 1992), *Blephilia subnuda* (Simmers & Kral 1992), *Solidago arenicola* (Keener & Kral 2003), and *Xyris spathifolia* (Kral & Moffett 2009).

Kral's efforts to examine and understand Alabama's plant life will never be matched. The most prolific botanist in the history of the state, he has collected over 100,000 specimens—all with his iconic "R. Kral" signature. Since 1997, this unsurpassed collection has been housed at BRIT.

Younger botanists—most of whom are mentioned above—met with Kral quarterly from 2002 to 2008 to create a checklist of Alabama plants (Kral et al. 2011). In January 2012, the on-line Alabama Plant Atlas (http://floraofalabama.org), based on that checklist, was dedicated, housed at the University of West Alabama under the directorship of Brian R. Keener. The ultimate goal is to produce the "complete" written flora that Bob Kral has long envisioned. With points of emphasis now established at Troy, Auburn, Mobile, Montgomery, Livingston, Jacksonville, Anniston, Birmingham, Tuscaloosa, and Florence, that task is sure to be accomplished.

Thanks, Bob, for carrying us this far.

## ACKNOWLEDGMENTS

This paper has been forty years in the making. It started as a card file of references to early works. Guy Hubbs "fed" me everything he came across describing early Alabama landscapes, while Tamara Haygood sent her extensive holdings on Southern botanists.

In January 2012, an outline was presented at the dedication ceremony for the Alabama Plant Atlas. I thank Brian Keener for forcing me to finally pull my notes together.

I also thank Liz Wells of Samford's Special Collections for locating obscure genealogy records. Robert Steen helped me understand the history of LaGrange College. And Wayne Barger directed me to Mike Palmer and his great list of floras.

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I apologize to any Alabama botanists who feel slighted or left out of this treatment. Please realize that recent works—those published after the 2011 checklist—have been purposely left out, as have most short papers on additions to the state flora. An updated (and, hopefully, complete) list of works is maintained by the Alabama Plant Atlas. If your work is not cited there, we will make sure it is!

I also apologize to anyone who objects to my use of "Cro-Magnon" in the title. I realize that the term is both outdated and inaccurate, but I needed its alliterative effect—and to indicate the continuing evolution of botanical knowledge. It's a "stretch" that Lloyd Shinners, the founder of this esteemed journal, would appreciate.

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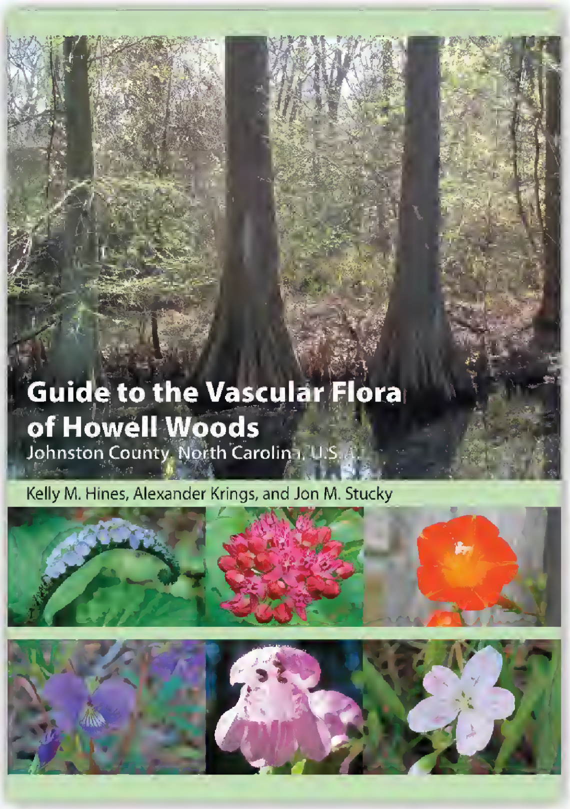
# BOOK NOTICE

Kelly M. Hines, Alexander Krings, and Jon M. Stucky. 2015. **Guide to the Vascular Flora of Howell Woods, Johnston County, North Carolina, U.S.A.** Sida, Botanical Miscellany 43. (ISSN: 0833-1475; ISBN: 978-1-889878-47-8, pbk). Botanical Research Institute of Texas Press, Fort Worth, Texas 76107, U.S.A. (**Orders:** shop.brit.org, orders@brit.org, 1-817-332-4441). Price to be determined, 276 pp., 7" × 10".

*From the Publisher*—Howell Woods Environmental Learning Center (Johnston County, North Carolina; "Howell Woods") is "the most significant terrestrial natural area in the county" as designated by the NC Natural Heritage Program. Comprising 1155 ha, the site is one of the largest tracts of intact forest remaining in the county. Howell Woods is home to ten natural plant communities and numerous rare plant species. *Guide to the Vascular Flora of Howell Woods* provides a checklist of the flora compiled from the first author's collections, historic collections, and reports of species from the site. The illustrated guide is based on the checklist of over 580 species in 123 families and includes 108 new county records. Keys are provided to all vouchered or reported species and genera. Habitat, exotic status, flowering and fruiting phenology, abundance, and synonymy are incorporated. In addition, relevant voucher information is provided. This is first in a series of Illustrated Floras of North Carolina Project from the North Carolina State University Vascular Plant Herbarium (NCSC), designed to be useful to both botanical specialists and a more general audience.


Guide to the Vascular Flora
of Howell Woods
Johnston County, North Carolina, U.S.
Kelly M. Hines, Alexander Krings, and Jon M. Stucky

**Kelly Thames** (née **Hines**) is a wetland scientist at an environmental consulting and habitat restoration firm continuing her interests working with the public, plants, and the natural world.

**Alexander Krings, Ph.D.** is Assistant Professor of Plant Biology and Director of the Vascular Plant Herbarium at North Carolina State University. The central focus of his work is the discovery, taxonomic circumscription, and monography of plants and the subsequent development of applied resources that facilitate plant identification and related communication. Dr. Krings is also author of the Manual of the Vascular Flora of Nags Head Woods, Outer Banks, North Carolina (2010) published by the New York Botanical Garden Press.

**Jon M. Stucky, Ph.D.** is Professor Emeritus of Plant Biology at North Carolina State University. He has taught undergraduate and graduate level field botany courses for over thirty years, including Systematic Botany, Grasses, Sedges & Rushes, Wetland Flora, and Local Flora. Dr. Stucky's research focused on rare plant species ecology and conservation.

# BIRCH (*BETULA*, BETULACEAE) BARK HORNS AND SIMILAR INSTRUMENTS IN NORWAY

Torbjørn Alm

*Tromsø Museum*
*University of Tromsø*
*P.O. Box 6050*
*Langnes, N-9037 Tromsø, NORWAY*
*torbjorn.alm@uit.no*

## ABSTRACT

Wooden horns wrapped in coiled birch bark (Norwegian: *lur*) have a long history in Norway, dating back at least to the 7th century AD. By the Vikings, they were used for various signalling purposes, e.g. during battles. More recent uses are generally peaceful—to celebrate the opening of fairs, announce bishop visitations etc. In the 19th century, playing such instruments was as a popular past-time when herding cattle, and, if needed, to scare off predators (bears, wolves, etc.) or signal for help. Common throughout the southern part of Norway, such instruments gained symbolic importance during the 19th century national revival.

## RESUMEN

Los cuernos de madera envueltos en corteza de abedul enrollada (en noruego: *lur*) tienen una larga historia en Noruega, al menos hasta el siglo VII AD. Los Vikingos, los usaron con varios propósitos de señalización, ej. durante las batallas. Los usos más recientes son generalmente pacíficos—para celebrar el comienzo de ferias, anunciar visitas de obispos etc. En el siglo XIX, tocar tales instrumentos fue un pasatiempo popular cuando se cuidaba el ganado, y, si era necesario, asustar a los predadores (osos, lobos, etc.) o como señal de auxilio. Comunes por toda la parte sur de Noruega, tales instrumentos ganaron una importancia simbólica durante el renacimiento nacional del siglo XIX.

## INTRODUCTION

Plants are versatile raw materials, and wood and bark can be used to produce a vast range of utensils. McCune and Prendergast (2002) drew attention to the use of birch (*Betula*) for making musical instruments or simple wooden horns in Europe, commenting on examples from Finland, Norway and Switzerland, based on specimens in Kew's Economic Botany Collection. No primary data from Norway were included, and a rather ecclectic selection of other sources was used—but then, very little information is available in English. This paper aims at a comprehensive review of such wooden, bark-covered horns (Norwegian: *lur*) in Norway—history, materials, traditions, and uses.

For a botanist living in the far north of Norway, a striking aspect of the Norwegian birch bark horn tradition is it geographical distribution. Such instruments are well known and deeply rooted in folk tradition of the south, and rare in the north—despite the fact that ideas, traditons and innovations are easilly transmitted along Norway's long coast, always a major communication route. The difference is certainly not due to topography, which is equally rugged in the north, suggesting a similar need for signalling instruments. This aspect has been overlooked in available literature, and trying to explain it is a second goal of this article.

### Etymology

The root meaning of the Norwegian word *lur* (old Norse *lúðr*) is a hollowed-out piece of wood, not necessarily a musical instrument (Christiansen 1952a, 1952b; Holtsmark 1946). The Norse god Heimdall possessed a famous example, *Gjallarhorn*. According to Norse mythology, and the poems of the younger Edda, "he has a *lur* called *Gjallarhorn* and his *lur* playing can be heard everywhere."

A brief definition of such instruments is found in a late 17th century manuscript by Thomas Bloch, comprising a dictionary of terms used in Fyresdal, Telemark: "*Luu,* Instrumentum est, ut tuba, factum è ligna excavato, betulæ cortice circumvolutum, qvô pastores sonitum dant ad arcendos à pecoribus ursos et lupos,—is an instrument, made as a trumpet of hollowed out wood, wrapped in birch bark (Fig. 1), which the shepherds

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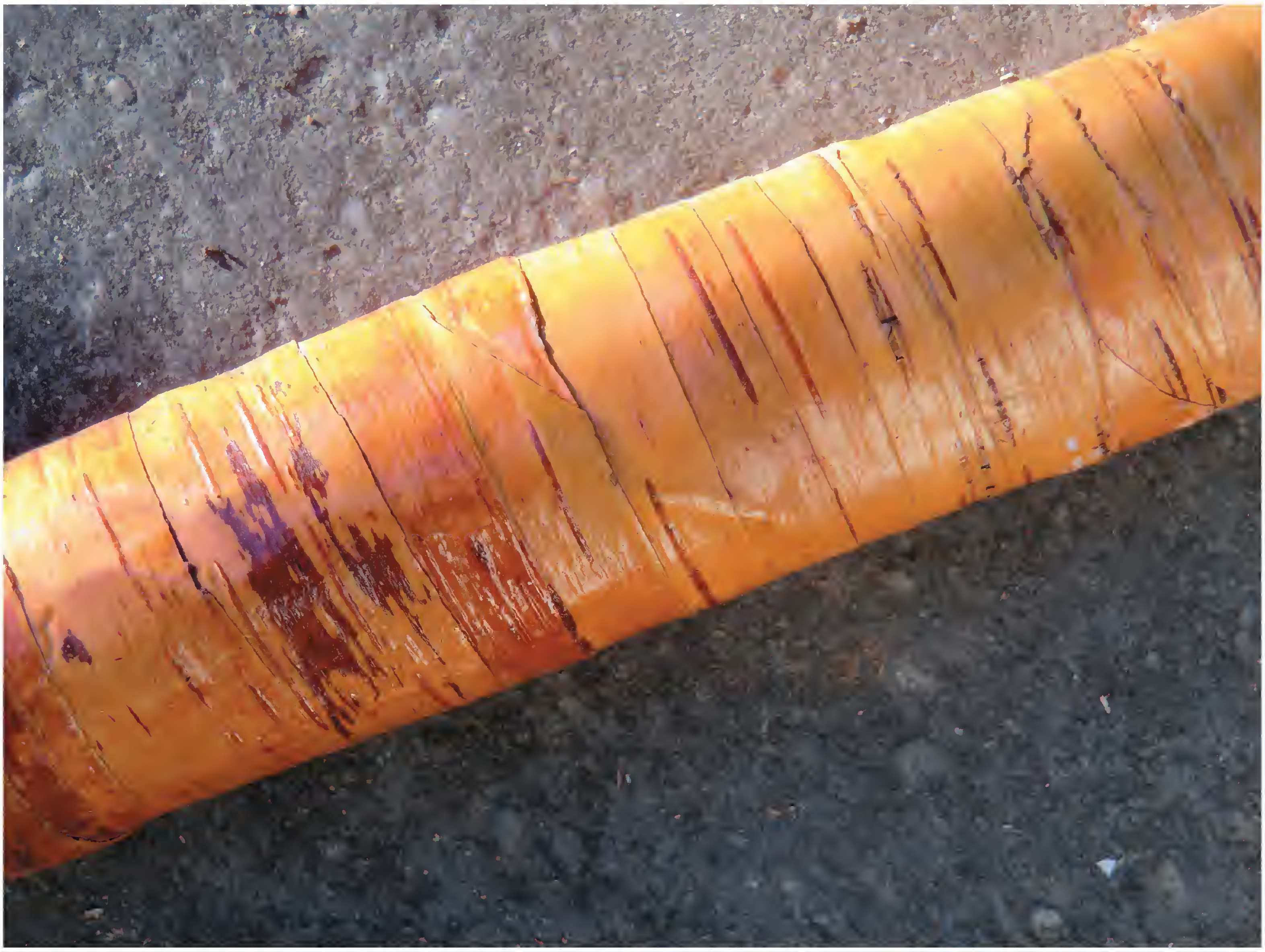

**Fig. 1. A typical Norwegian *lur* is covered by a coil of birch bark, serving both a decorative purpose and to keep the two halves of the interior wooden kernel together while blocking leakages.**

blow to scarce bears and wolves away from the cattle" (Bloch 1956:23). Knud Leem's Norwegian dictionary, compiled in the 1740s, offers a similar explanation: "A *luur*: an almost one fathom [1.73 m] long instrument made of wood (Fig. 2), and covered with birch bark, which the peasant girls use to blow, mostly in summer, when they are herding the cattle, partly for amusement, but also to scare off the bear" (cited from Hannaas 1923:120). An anonymous, late 18th century dictionary manuscript from Surnadal in Trøndelag provides similar information: [an instrument] "(…) for blowing, so that the sound can be heard loudly among the surrounding hills, and the bears in particular are scared and driven away from the cattle" (Hagland 1986:47).

The term *lur* has also been applied to a variety of other objects, e.g., hollow plant stems (Christiansen 1952a, 1952b: Myrvang 2010), which were frequently used as simple pipes, e.g., by children. In toponyms, it may refer to the occurrence of plant species with this characteristic, e.g. *Angelica sylvestris* L. (Myrvang 2010:186).

## History

As noted by McCune and Prendergast (2002), a wooden horn or *lur* was found in the Oseberg Viking burial ship, dendrochronologically dated to 834 AD. The specimen was 107 cm long and had a diameter of 4 cm at the broad end (Grieg 1928; for an illustration, see Christensen et al. 1994:134 or Vollsnes 2001:49). In a recent archaeological review of the Oseberg find (Christensen et al. 1994), the specimen is considered somewhat enigmatic, as a "scepter, blowing *lur* or ???", but the description (Grieg 1928:270–271) fits a typical *lur*—a meter-long, wooden tube, tapering towards one end, consisting of two halves, with a somewhat irregular interior hollow—and there is hardly any reason for interpreting it otherwise, even though it had not been covered with

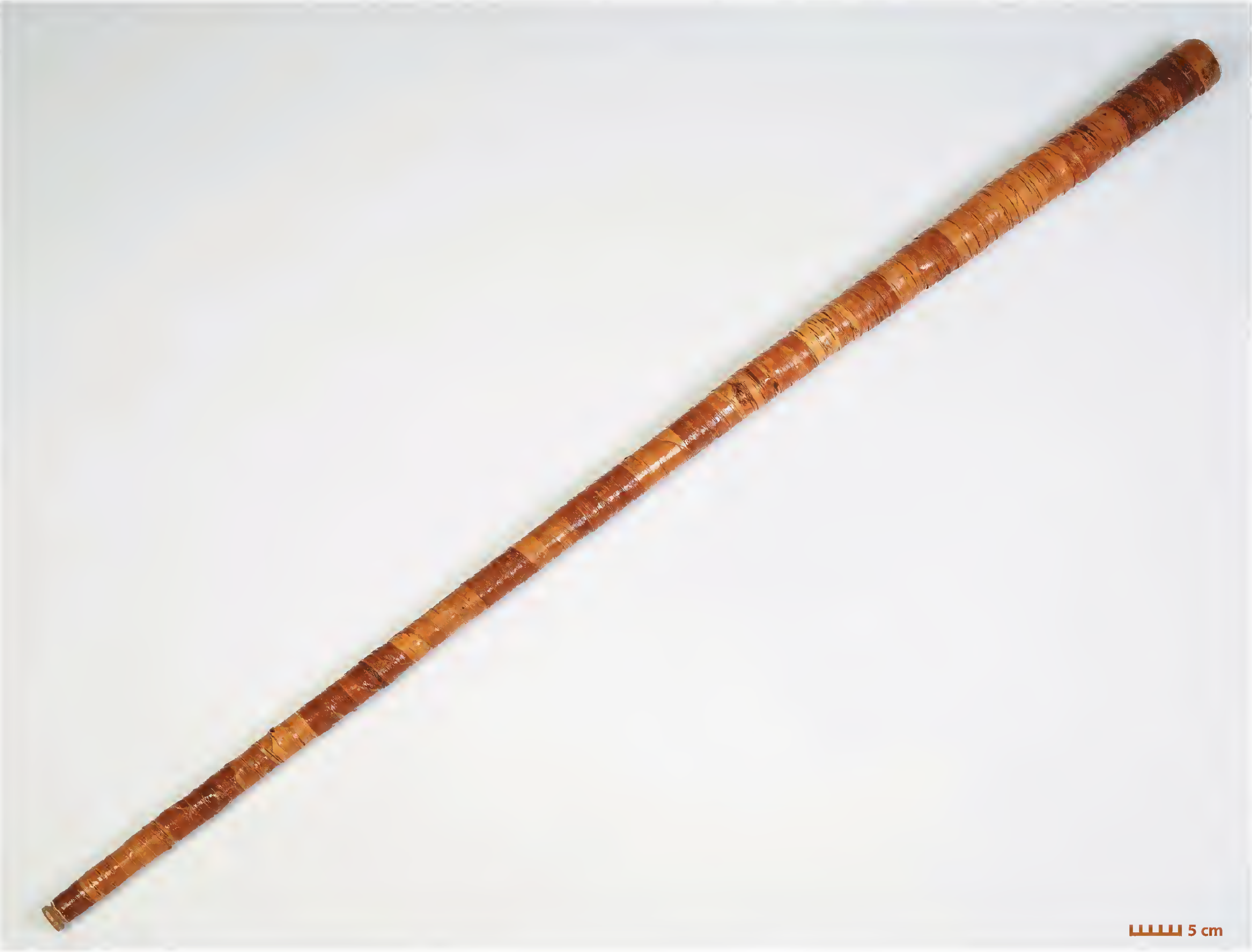

Fig. 2. This medium-sized instrument (length: 1.53 m) is easily carried, weighing a mere 520 g. Author's collection. Photograph by Mari Karlstad.

bark. Instead, the two halves were kept together by bands, attached in five incised rings. This technique is typical of Viking-age or older specimens (Vollsnes 2001:49) but was still used in parts of Norway as long as such instruments were commonly made, i.e., throughout the 19th century (Gundersen 1994:19).

An even older specimen from Norway was found in the Kvalsund ship burial, unearthed at Herøy in western Norway and dated to about 600 AD. It contained a short *lur*, 72.5 cm long, with a diameter at the widest end of 4.5 cm (Shetelig & Johannessen 1929:70). The short length may suggest that it had not been used as a musical instrument but perhaps as a kind of megaphone (Shetelig & Johannessen 1929:39). Similar wooden megaphones were used by fishermen in northern Norway until perhaps a hundred years ago (Christiansen 1952b:108).

## Making and materials

Several authors provide notes on how to make a *lur*. The most frequently used technique was to make two separate halves from a single piece of wood. It should be noted that Norwegian wooden horns are not exclusively made from birch wood and birch bark. This choice of material may have been most typical for the coastal districts, where *Betula* species are the predominant forest trees. Indeed, according to the original publication (Grieg 1928:270), the Oseberg *lur* noted by McCune and Prendergast (2002) was made of beech (*Fagus sylvatica* L.); more recent authors (Vollsnes 2001:49; Gundersen 1994:19; Sevåg 1966:10) state that the material used was yew (*Taxus baccata* L.), but no reason for doing so is given, and no revision of the original material has been carried out (Arne Emil Christensen, pers. comm.).

In many areas, not least inland, conifers were preferred as raw material for the interior wooden tube. In southeastern Norway, spruce (*Picea abies* (L.) Karst.) was frequently used. Trees that had grown slowly were preferred. In the Hallingdal area, pine (*Pinus sylvestris* L.) was considered the best raw material (Gundersen 1994:22–23), not least because suitable working material could be found as preserved, subfossil stems in the mires; such material was considered less "fat" than fresh pines. Living pines could also be used; if so, they were split lengthwise from the bottom end. A single log could produce numerous instruments (Gundersen 1994:23).

The material chosen for the tube had to be of a certain minimum size, as the central part of a stem was avoided (Gundersen 1994:23). The halves were hollowed out, by knife or other tools. Using a knife would usually produce a more or less square interior hollow (Gundersen 1994:23). The two halves were then re-assembled. Some would glue them together, but others considered this to give instruments of inferior quality (Gundersen 1994:23). This is why they are wrapped in bark; a long, coiling strip of birch (*Betula*) bark served to keep the two halves together. Making the *lur* air-proof was essential, and the bark would also block potential holes or leakages. In addition, it obviously had a decorative function.

Instruments could also be made from bark only, coiling it up into a small cone, usually some 40 to 60 cm long (Nupen 1992:16). In addition to birch, bark of rowan (*Sorbus aucuparia* L.), alder (*Alnus* spp.), and the larger *Salix* species could be used (Hooker 1837; Christiansen 1952b; Høeg 1974; Nupen 1992; Dahl 2005:303). Even these simple instruments could survive for years but may have served mostly for children's amusement (Hooker 1837).

Birch bark for the covering coil of a conventional *lur* was cut from the trees in spring or early summer (Gundersen 1994:24; Dahl 2005:303). Straight, tall-grown trees were preferred, as only these would yield bark of suitable quality—preferably white and with few scars (see discussion). With a knife, a spiral was incised, starting at suitable height, and the outer layer of the bark peeled off, so that one exposed the green, interior part (Gundersen 1994:24). The white outer skin was then removed, leaving the detached, yellow-brown part ready for use or almost so; the margins might need some trimming. The bark was attached to the *lur* while still fresh. Winding it onto the *lur* could start from either end. The start would lock itself. At the far end, the bark strip could be locked by inserting it under the coil. Small wooden plugs were often used as an additional way of securing the end. An experienced cutter could make very long coils; Hatledal (1997:6) mentions specimens up to 6 and 7 m long. He also noted that the trees survived, forming what he terms *korpebark* ("raven bark") at the cut.

A detailed description of how to make a *lur* is provided by Ola Hola, based on traditions in Møre og Romsdal County, western Norway (Hola 2000:66–67). In this case, pines were preferred for the wooden core. The trees were cut before Christmas, while the moon was waning. They were split lengthwise, placed beneath a roof, and left drying for one year. From this material, a tube was prepared, some 80 to 90 cm long, with an interior diameter of about 6 mm at the thinnest end, gradually increasing to 14 mm towards the other end of the tube, until 14 cm was left. From this point, the diameter increased rapidly towards the outermost part (*sopen*), which had a diameter of about 10 cm. The wooden frame was 2.5 to 3 mm thick, except at both ends, where it was thicker. The *lur* was now covered with birch bark. This could only be done in summer. A fine, even-surfaced, young birch was chosen, and the bark cut spiral-wise downwards with a sharp knife. Each incision should be about 18 mm apart, so that the bark could be sliced off as long bands. The outermost skin was peeled off. The initial end of the strip was tapered so that it was only half as wide as the rest. Starting at the mouthpiece, the bark was wound onto the tube, with an overlap for each layer of about 3 mm. The bark should be attached tightly, so that it was stretched a little; this would press the two halves of the tube together. If the bark needed mending, it was done in the same way as at the start of the tube. The end was attached with three small wooden pins. Before the *lur* was used, clean water was poured through it. Instruments could also be made from a single piece of wood. This would avoid the risk of holes or leakages, but the preparation would be much more difficult.

## Shape and dimensions

The typical shape is that of a long cone, simply because it produced the best sound. A cylindrical *lur* was a bad instrument (Gundersen 1994:23). The diameter at the widest end could be some 85 to 100 mm (Gundersen

1994:2; Hola 2000:66). The mouth-end had a diameter of 10–12 mm or less (Fet 1991:23). Some horns were simply cut at the mouth-end; others had a more elaborate mouth-piece. The latter could also be loose and made of wood, horn, or bone.

The Kew example of a Norwegian *lur,* depicted by McCune and Prendergast (2002), is 158 cm long. This is a medium-size instrument according to Norwegian standards. Both much shorter and much longer instruments were made. The shortest, known as *stuttlur* "short lur," *notatut* etc., could be a mere 30 to 40 cm long (Nupen 1992:15), while in other areas 60 cm was considered a minimum (Gundersen 1994:24). A typical *langelur* "long lur" would be about 150 cm, i.e., similar to the Kew specimen. Much longer examples were sometimes produced. The longest instruments made in the Hallingdal area exceeded 3 m (Gundersen 1994:24), but these were probably rare exceptions.

The collections at Norsk Folkemuseum (Norwegian Folk Museum) in Oslo contain about twenty specimens; most are of the medium-sized *langelur* type, i.e., more or less similar to the Kew specimen; four are of the *stuttlur* type. Two deviant, short specimens made of bark only are described as *orelur,* i.e., made of alder (*Alnus* sp.). Photographs of all these can be seen at museum's home page (www.norskfolke.museum.no).

At Stange in Hedmark, Embret Mæhlum was known for his fine *lur* playing. In the 1880's, he made an unusually large specimen, and it is unlikely that a larger *lur* was ever made:

> "But this large *lur,* he made after returning home [from America], and he had worked on it for a whole year. It was completed in 1886. He found a knotless spruce up in Præstmark'n. He cleaved it along the middle, and then he started to hollow it out, so that a thin pipe extended all through it. Then, he wrapped the *lur* in pieces of birch bark and glued it together. It was very well done." (...) "He also made a stand for it, on which he placed the *lur* when he was playing. The *lur* was enormous. It was 5.39 meters long. I believe it must have been the largest *lur* in the world but its weight was no more than 3.6 kilos" (Engen 1991:103).

The motivation for making instruments of varying length was two-fold, practical and musical. A very long instrument could not easily be carried around, e.g., when herding livestock. This was a task often carried out by children, which again would require rather short and small instruments. Musical considerations would rather motivate long instruments. The longer the instrument, the more different tones it could make (Gundersen 1994:24; Nupen 1992:15). In addition, the loud sound of a large specimen could be heard far away. The sound produced would still vary a lot between individual instruments, and some were better than others. At least locally, holes could be drilled in the side of the *lur* to provide further musical variation (Mørch 1964:182).

### Purpose

In the Norse-Icelandic sagas, the *lur* is more frequently mentioned than any other musical instrument (Vollsnes 2001:48), though there is nothing to suggest that its use during the Viking age was for entertainment. Most references point to a military use, as a signal during war and battles, e.g., to board ships, to rally at the king's standard, attack, or withdraw. The only old Norse law that explicitly mentions the *lur* is the *hirdskrá*, a military code for the royal guard (Sevåg 1966:10). At least some Norwegian kings possessed a personal specimen, *konúngs lúðr,* "the king's *lur*." The instrument of king Sverre (c. 1150–1202) even had a name, *Andvake*, and seemingly produced a special sound that his soldiers could recognize and know that they were called for (Vollsnes 2001:51). When Scottish mercenaries—hired by the Swedish king—tried to march through Gudbrandsdalen in SE Norway towards Sweden in 1612 (see Michell 1886), a *lur* was used to signal their approach to the log trap that killed many of them. It was launched "just as they paused to listen to Prillar-Guri, who stood on top of the slope on the opposite side of [the river] Lågen and blew a *lur*" (Botten-Hansen 1853:63), or so the legend says—whether true or not. Local tradition has been busy embellishing the peasants' victory story with additional details, e.g. that the Scots took revenge by introduction *Cicuta virosa* L. to the area—and to Norway; both claims are at odds with reality (Alm 2015).

If need be, the instrument could also be used to signal the presence of thieves and other criminals (Nystugun 1950:120–121). The lur was also used as a calling signal at more peaceful occasions, e.g., during assemblies of various kinds. The latter use declined by the 13th century, when the Christianization of Norway had led to churchbells taking over the old calling function of the *lur* (Vollsnes 2001:54).

Among the many legends related to the Black Death in Norway, a favorite topic is the desolation met with afterwards, frequently in terms of a single survivor in each isolated settlement. Their presence was ascertained by the sight of smoking chimneys or, according to local lore, by signalling with wooden horns, e.g., at Rauland in Vinje, Telemark (Berge 1940:123), and at Kvikne in Nord-Fron, Oppland (Klonteig 2007:73).

As noted by McCune and Prendergast (2002), wooden horns were frequently used as herding instruments, in particular in high summer when the herds were moved to separate summer farms (Hornemann 1808:404; Lie 1914:186; Bjerknes 1945:50; Holtvedt 1945:124; Svarteberg 1968:50; Perstølen 1970:90; Svare 1973:241; Sem 1983:11; Engen 1991:103). The horns could signal that the herd had been located or be used to ward off predators, especially bears and wolves (Hagemann 1889:121; Slingsby 1904:87, 1966, 1998:58, 70; Hannaas 1923:120; Frølich 1924:161; Sagen 1950:246; Holtvedt 1945:125, 1953:138; Høgåsen 1949:139; Perstølen 1969:21–22; Sandåker 1976:61; Lodoen 1989:64; Tomasgard 2004:41; Dahl 2003:185, 2005:303; Nupen 2003:60), or simply to relay signals (Rise 1933:66). A *stuttlur* "short lur" in the collections of Norsk Folkemuseum (depicted in Nupen 1992:17) is inscribed 1862, the year it was made. An accompanying note tells its origin: "I also have a *lur* of birch which my father made in 1862 to scare off wolves and lynx when he was herding the goats." According to folk tradition, the bear was scared by the sound of a *lur,* whereas most claim that he enjoyed the tunes of the *prillarhorn,* which was made from a goat, sheep, or cow horn (Skar 1911:96; Mørch 1964:181; Perstølen 1970:94–95; Gundersen 1995:73). From the Oslo area, Holtvedt (1953:138) noted that bears disliked the sound of the *lur*: "But the best thing to do was to blow the *lur* close to his ear; he did not like the sound. He wanted it quiet." In his childhood in Hornindal (Hordaland, western Norway), before emigrating to the U.S.A., I.N. Lodoen used his *lur* to ward off an attacking bear while herding cattle and sheep:

> "The cows had formed a circle and the sheep were tightly grouped. Calves and younger animals were surrounded for protection. The situation was tense. A big, black bear stood close to me and was about to catch his prey. What could I do, and what should I do in this critical situation? I had no other weapon than my *lur.* It appeared a weak weapon against such a bear. But I started blowing the *lur.* Did I blow hard? I must have done so, for I frightened the beast. He ran and ran without halting, and disappeared up the mountain side at the other side at full speed. The battle was won and the herd saved. It took some time for the cattle to calm down, and the sheep to comprehend. After a while, I was able to drive the animals down to the summer farm, and all was well. The sound of the *lur* had been heard, and people came running to help me" (Lodoen 1989:61–62).

At least once, the *lur* was put to more prosaic use in order to chase off a bear, as noted from Vefsn in Nordland, North Norway:

> "The bear took a sheep once grandma was herding. She ran after him and hit him with a long, large *lur* she had. The bear was about to carry the sheep across a brook, but now he let the sheep loose, and attacked grandma instead. He bit her in her thigh, and she had a large wound" (Svare 1973:240–241).

It was obviously better to chase off the bear with the loud sound of the *lur.* The sound's ability to carry far is the point of a humorous folk tale, describing a fabulously large cow:

> "(…) and the distance between her horns was so large, that if there was a herder sitting on each horn blowing a *lur*—some even said trumpet blowers—they could not hear each other" (Holtvedt 1953:144).

In the 19th century, the sound of the *lur* was an integral part of the landscapes of southern Norway and encountered almost everywhere (Søegaard 1868:100). It is frequently mentioned (e.g., in tourist travel accounts), often in more or less romantic settings such as in an account of a visit to mountains of Telemark in 1834: "At first, we passed over a wooden bridge, beneath which the rapids of Måneelven [the river Måna] raged, and so, while the *lur*s were sounding up in the mountains, our alpine travel commenced" (Hammerich 1840:36). The English mountaineer W.C. Slingsby encountered children with wooden horns at several occasions, e.g., at Hellesylt in Stranda, western Norway, in 1875:

> "Near Indre Haugen we met at different places children carrying a 'lure'—a long wooden horn or trumpet, seven to nine feet in length, formed by two split and hollowed pieces of wood put together and bound firmly by birch bark, out of which material a bell mouth of five or six inches diameter is also formed. The boys blew these 'lurer' most vigorously in order to frighten away the bears which had just killed two cows at Haugen" (Slingsby 1904:87).

The instrument is also mentioned in early accounts of the folklore of Norway, e.g., in the legends recorded by S.O. Wolff in Telemark:

> "Countless and differing sounds almost numb the ear, among them the chiming of bells and the tune of the *Luur,* which come from the rivulet, where some children are standing with their fishing rods" (Wolff 1828:74, reprinted in Wolff 2014:137).
>
> "She blew her *Langeluur* [long *lur*] so that *Veirmaalet* [the dwarf's speech, i.e., the echo] answered from all the krags, and you could easily tell, where Guro Dalen's summer farm was situated" (Wolff 1833:14, reprinted in Wolff 2014:82–83).

As a herding instrument, the *lur* was still frequently heard during the last half of the 19th century. It features prominently among the sounds noted by Ernst Bjerknes in the Krødsherad area of SE Norway during a summer visit in 1883:

> "For a long time, we had heard the sounds of bells and the mooing sound of the cows from both sides of the mountains; now the siren calls of the dairy maids were added, and the cows answered. It turned into a beautiful antiphony, sometimes accompanied by the *lur* or the roaring sound of a *prillarhorn*. It all melted into a glorious symphony of captivating beauty in the still, warm summer night" (Bjerknes 1945:50).

Tourists visiting the Hjartdal area of Telemark in 1899 heard similar sounds: "Day and night you hear the sounds of *lur*, calling [for cows], and chiming bells" (Dahl 2005:264), and the sounds of nearby Fyresdal were much the same: "There I heard the tunes of a *langelur* [long *lur*], and I turned towards the sound, and far away below Raufjell I saw a fine herd grazing. The shepherd girl stood on a big stone with the *lur* in her hand, and a small boy was sitting nearby on a tussock" (Lie 1914:186). Even in the vicinity of Oslo, the capital, the *lur* was frequently heard:

> "When they were at Oppkuven, they heard all the blowing of *lur*s on the summer farms at Krokskaugen—Come home now! Come home now! they signalled to the cow[s] both from Vakersetra and Heggelisetra and Gagnumsetra and other summer farms as well" (Holtvedt 1945:56).

A *lur* could be used for any kind of signal and was useful for communicating across the often steep terrains of Norway (Perstølen 1970:91), not least in foggy weather. In some areas, dairy produce was shipped down the steep mountain sides attached to wires, and a *lur* could signal that a new batch was on its way down (Nupen 1992:15). In western Norway, a short wooden horn or *notatut* was used to signal that shoals of herring had arrived. The sound of a *lur* could easily be heard on the other side of a fjord (Fet 1991:23; Nupen 1992). Others used it to signal that a meal was ready (Holtvedt 1945:125). It was also useful if you got lost in the forest or mountains (Holtvedt 1945:169–170). Bakke (1990:219) provided some further details from Fræna in Møre og Romsdal, western Norway. Here, the instrument was used to signal meals or the end of the working day. Some would also agree on a way of translating the sounds produced into words, in which case questions, as opposed to statements, were indicated by repeating the signal twice.

As noted by Ile (1960), from the Øyer area of interior SE Norway, a *lur* could serve as a past-time for herders but would sometimes be put to more serious use:

> "Quite a few herders had a *never-lur* [birch bark horn], but they were mostly used by boys, rarely girls. The *lur* tones could be heard for a long distance. A *bokkehaunns-stut* [instrument made from a goat horn] was more common, both with girls and boys. Both the *lur* and *stut* were mostly used for fun and as a past-time. However, if some danger occurred, or an accident struck (for instance that predators were at large, or a cow had collapsed), so that the herder needed immediate help, he could sound a signal or alarm. Furthermore, it is likely that the well-known sounds of *lur* and *stut* could help in keeping the cattle collected, and perhaps entice them to return home at night" (Ile 1960:62).

Opedal (1984) provides two examples of the instrument's use to keep livestock safe in the Kinsarvik area of Hardanger (Hordaland, western Norway):

> "There was a lot of bears at Tjoflot. At Storahøytrædet, the dairy maids stayed in a chalet while herding. The bear came at night, and so they had to go outside with *neverlurar* and scare him off" (Opedal 1984:109).
>
> "The bear would ravage the sheep.—At Djønno, they had to keep them in a fence at night. We could hear the herdsman blow his *lur,* and how he hit the chalet's timber walls to scare the bear" (Opedal 1984:109).

It should be noted that not all references to a *lur* or *neverlur,* even in this context, refer to the musical instrument. Five more records in Opedal's vast collection of Hardanger folklore may be included to avoid confusion. In these cases, in Kvam and Ulvik, the kind of *neverlur* used to chase the bear was not an instrument but simply a curled-up piece of birch bark, set on fire to scare the beast:

> "And now, the bear was walking around the summer farm. Then, another dairy made put a burning *neverlur* out through the door opening. This scared him" (Opedal 1984:130).
>
> "At another occasion, the bear came to the summer farm. It was in the evening, and the cattle got wild. She heard how he padded about sniffing in front of the chalet. Then, she set birch bark on fire and opened the door. And there the bear stood! And she pointed the *lur* at him. He turned around at once (…)" (Opedal 1984:130).
>
> "Afterwards that summer, the dairy maids alighted *neverlurar,* so that they could keep the bear away" (Opedal 1984:135).
>
> "At Kleivsæter, my grandmother (born 1834) put *neverlurar* on fire to ward off the bear. She followed him with the fire and said: "Burn, burn the fur!" Then, the bear got scared and left the summer farm, running up the mountain slopes" (Opedal 1984:139).
>
> "Every now and then, the bear would haunt the summer farms. The dairy maids alighted *neverlurar* and tied them to long sticks, and pushed it into his fur. Then he ran" (Opedal 1984:121).

At Hornindal in western Norway, a herding boy used his *lur* to alert his family when both he and his flock of sheep had been taken by an avalanche during the late 19th century:

> "I had a *lur.* It was made of birch bark and five foot long. I carried the *lur* with me everywhere. The sound it made could be heard for a long distance. I had used this instrument so much that it was not difficult for me to produce a loud sound. When the avalanche had passed and I saw what had happened to many of the sheep, I started blowing the *lur* loudly and for a long time. And they heard me at home! After a while, help came, and we collected the dead sheep. The meat and skins could still be used" (Lodoen 1989:62–63).

In his account of the "life of a Norwegian peasant family", Botten-Hansen (1854) noted that children might play the *lur* after finishing the day's herding:

> "In particular, they were happy when they returned from the mountains, and the herd, well-fed by the fat grass and tired of being chased by the horseflies, settled in the summer-farm yard, ruminating while waiting to be placed in the stall. Then, Ole stood alongside Marit, who was busy knitting, playing his *lur* so beautifully that the surfeited cattle, despite their laziness, would turn their heads against him, (…)" (Botten-Hansen 1854:43).

In southern Norway, the *lur* was such an integral part of farming practice that even the subterraneans, who according to folk tradition were also herding cattle, could not do without them. At Krondalen in Jostedalen, people had "seen a herd belonging to the subterraneans with a dairy maid, dog and pack horse etc. heading for [the glacier] Krondalsbreen, accompanied by the sound of song and *lur* tones" (Asbjørnsen 1850:69). A legend from Flatdal in Seljord, Telemark relates how some mythical maidens played *lur* on a Sunday and enticed a whole crowd of people attending sermon to leave the church in order to listen. The disturbance lasted until the vicar also came outside and admonished the disturbing maidens to go into the rock (Schwach 1921:19). According to the witch trials of Finnmark, northernmost Norway, even the devil played a *lur* while entertaining witches at black sabbaths (Bætzmann 1865:47).

Some were obviously more skilled at blowing a *lur* than others. Embret Mæhlum at Stange in Hedmark, mentioned above, gained his nickname of Tuter-Embret ["hooter-Embret"] from his skills. He obviously enjoyed playing, for

> "each year on the 17th of May [Norway's national day] he climbed up to this vast pine at Stortøsti. There, he placed the *lur* in the cleft of the pine, and stood there playing national songs" (Engen 1991:103).

Embret visited numerous other locations with his instruments. Another skilled player, Andreas Ullevålseter, allegedly could blow his *lur* in such a way as to accompany traditional dancing (Holtvedt 1945:125). At Hornindal in Hordaland, Renda-Hans was another reputed *lur* blower (Løvlid 2000).

Nowadays wooden horns are mostly used for festive purposes, e.g., to signal the opening of fairs (Sevåg 1966:16) or other special occasions (Engen 1991:105) and at the opening ceremony of the 1994 Winter Olympic Games at Lillehammer. Such use is well rooted in past traditions. There are several accounts of similar use during the 18th and 19th century, at the opening of banquets and to welcome clerical dignitaries, e.g., at bishop visitations (Wiel 1802–1805; Mehlum 1891:17; Myhre 1928; Vollsnes 2001:72). During the 19th century national revival, the *lur* served as a kind of national symbol. It is featured on the front cover of a Norwegian ABC book (Austlid 1880) and in romantic illustrations of peasant life (e.g., Østgaard 1852, as frontispiece in some reprint editions). Wooden horns are depicted in some foreigners' accounts of travels in Norway, e.g., Brace (1859; plate facing p. 56). W.H. Breton encountered the instrument in the Romsdalen area of western Norway:

> "While engaged in forcing my way on one side of the valley, I heard the notes of a horn, and discovered that the broken acclivities of the enormous bank, although to the eye ascent seemed impossible, admitted of pasturage for a few sheep. These were attended by a youthful shepherd, who performed his rude music upon a horn four feet in length, and made of wood; an instrument I had seen before" (Breton 1835:272–273).

### Ethnicity

All traditions noted above refer to the Norwegian majority population. It should be added, though, that similar instruments were used by the Finnish ethnic minority of the Finnskogene ("Finn forest") area of southeast Norway (Lindtorp 1940; Jenssen 2007:35). A *neverlur* (Finnish: *torvi*) from this area is described as follows: "For a long time, *næverlurv* (*torvi*) and buck horns (*pukinsarvi*) were the only instruments heard at Finnskogene, and some people were masters at using them. Birch bark horns and buck horns were mostly used by herders in forest and field, and their tunes could be heard for miles among the cliffs" (Lindtorp 1940:97).

## DISCUSSION

The birch is hardly mentioned in classical Greek and Roman sources, playing no role in their homelands (de Cleene & Lejeune 2003:150). A cursory treatment is included in book XVI of Pliny's *Historia naturalis,* where it is first referred to as a Gallic tree (XVI:74), noting its "remarkable white colour" and the use for various utility purposes (Rackham 1968:437). Pliny also comments on its use for withies (XVI:176, Rackham 1968:501) and the quality of the wood (XVI:209, Rackham 1968:525).

The birch is much more important in the north. It features prominently in the traditions of Central and Northern Europe and northern Asia, both in a religious context and as a utility. In Norse mythology, the tree was dedicated to Thor, the god of thunder and lightning.

Birch bark has been used for various purposes, e.g., as thatching on roof. Being strong and flexible, it has also been used to prepare baskets and shoes in Norway. Birch bark baskets (Norwegian: *neverkont*) were frequent all over the country and are still sometimes prepared and used. Birch bark shoes were previously much used by the Finnish ethnic minority of southeastern Norway (Matson 1908; Østberg 1935). Both these uses are also well-known in neighboring Sweden (Hasselrot 2005; Rosén 2005). Being highly inflammable, bark was and still is frequently used to light fires and has also served in torches (de Cleene & Lejeune 2003:157). Like many other kinds of bark, it could be used for tanning. The thin, inner bark has been used on wounds in both Norwegian and Sámi folk medicine.

Since antiquity, birch bark has also served as writing material (de Cleene & Lejeune 2003:157). The Sanskrit name *bhurja* means "the light tree or a tree with bark one can write on." In Norwegian sources, such use is first mentioned in the late 16th century by Peder Claussøn Friis (Friis 1632, reprinted in Storm 1881). He noted that bark was used for letters and as practicing material for children who were learning to write. Birch bark was still used for this purpose in the 18th century (Frimann 1885; Schübeler 1885:482).

A complex and dissected topography may have contributed to the prevalence of birch bark horns in Norway. They were once common all over southern Norway but seemingly little used further north. The distribution map in Fig. 4 is based on the same multitude of sources used for compiling this paper. It is likely to reflect the general pattern, even if most instruments have of course been made, used, and discarded without making it into literature or museum collections.

The sources are silent in terms of what kind of birch was used. Given the straight growth and the size of the stem, one may assume that *Betula pendula* Roth provided better bark and winding material than the lower, more crooked and richly branched *Betula pubescens* Ehrh. This may explain the absence or sparsity of *lur*-type instruments in northernmost Norway. The distribution of *Betula pendula* tapers rapidly out towards the north, and the species is sparse or absent in the three northernmost countries (Hultén 1971: map 597), mirroring the distribution of recorded instruments shown (Fig. 4).

The three northern outposts may deserve a comment. They are found, from south to north, in Vefsn and the Salten (Beiarn-Saltdal) area of Nordland, and in Bardu, Troms. In the Vefsn area, ropes served as a substitute for *Betula* bark, tying the two halves of the wooden kernel together (Fig. 3). Further north, the Beiarn-Saltdal area in Nordland, Saltdal in particular, has a favorable local climate, with hot and dry summers *and* a northern exclave of *Betula pendula* var. *lapponica* (Lindq.) Hämet-Ahti (see map in Elven 2013). The Bardu area lacks *Betula pendula*. It was, however, settled by people migrating north from interior SE Norway from the late 18th century onwards, thus coming from within the main distribution area of the *lur* (Fig. 4). They brought with them the tradition of making wooden horns and perhaps even some instruments. Thus, the distribution of the birch bark horn tradition within Norway is likely to reflect the availability of suitable winding material (i.e., bark from *Betula pendula*) rather than the need for or will to produce such instruments further north. Similar studies in Sweden or Finland may confirm this pattern.

It should be noted, though, that other predominantly ethnic Norwegian traditions taper out towards the

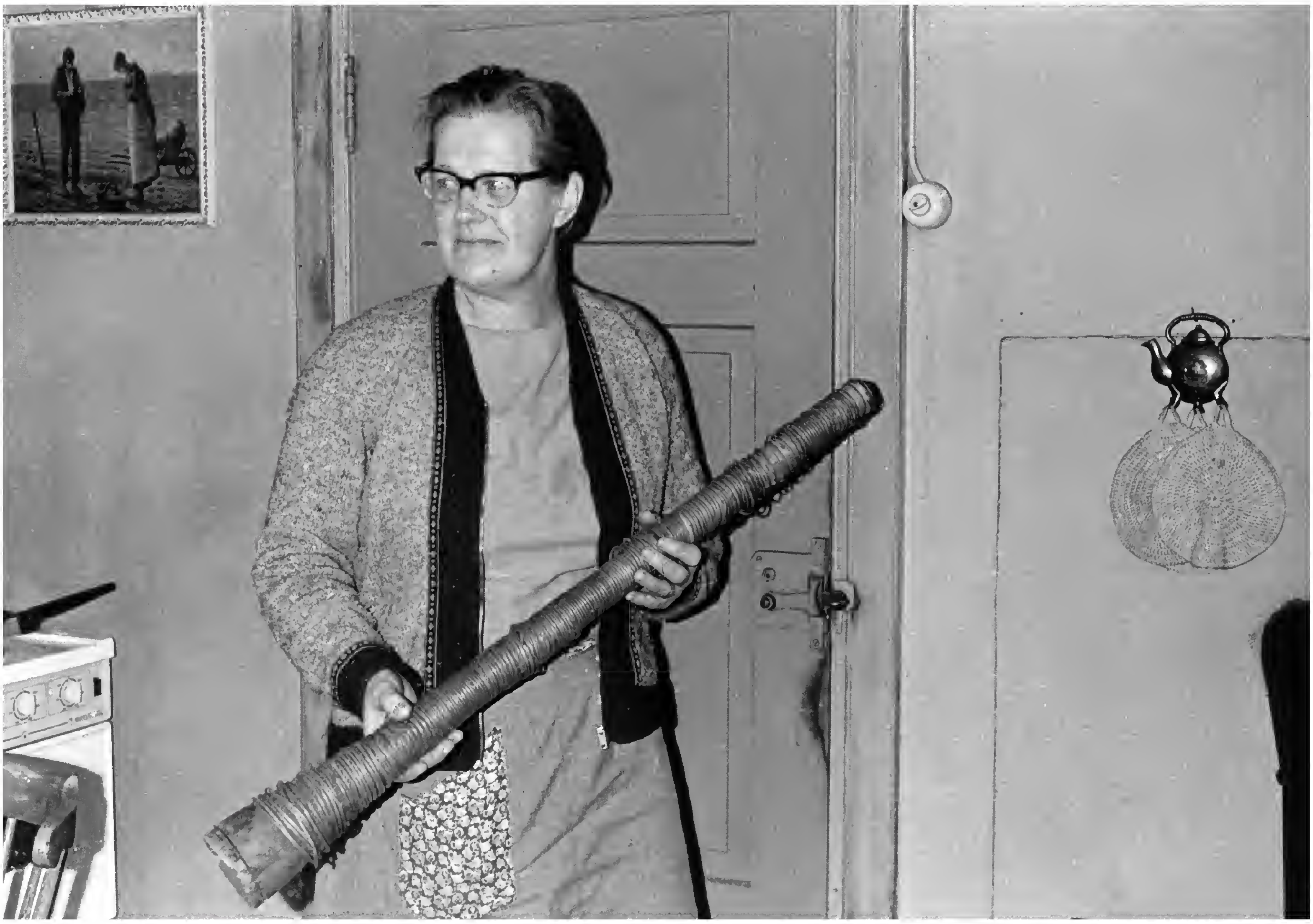

**Fig. 3. Norwegian female with a somewhat deviant *lur*, secured by a coiled-up rope, photographed in 1970 at Mjåvatn in Vefsn, Nordland, north Norway, by Arnt Bakke (photo archive of Tromsø museum, TSNF 9731).**

north, where local communities are more diverse and may be of either ethnic Norwegian, Sámi, or Finnish origin or a mixture of these. The traditon of planting *Rhodiola rosea* L. on roofs as a supposed (or apotropaic) protection againts fire is widely known in southern Norway, extending northwards into Nordland to the Beiarn area of Salten (Alm 2004), with a pattern almost identical to the distribution of the *lur*. The unique Norwegian tradition of using *Linnaea borealis* L. to treat shingles (herpes zoster) is also widespread in southern and central Norway but unknown further north (Alm 2006).

Sweden, with a more gentle terrain but as wide distances, can compete in terms of the number of wooden horns on record, e.g., in the collections of Nordiska museet (18 of these are depicted in Lid & Solheim 1936). Kjellström (1994) provides a brief, general account of "Scandinavian bark horns." More or less similar horns were used in Finland, e.g., to scare off bears (McCune & Prendergast 2002), but also featured in folk music (Austerlitz 2000).

Kew's Economic Botany Collections contain examples of birch bark horns from Norway, Finland, and Switzerland (McCune & Prendergast 2002), thus adding another European country with substantial topographic relief. In his lexicon of musical instruments, Sachs (1964) defines the *lur* simply as "das skandinavische Alphorn" ("the Scandinavian Alp horn"), although the Swiss *Büchel* horns deviate in shape from the simple Scandinavian tubes and include a convoluted, more or less trombone-like wind tube (Geiser 1976). Some of the Swedish birch barks horns depicted by Lid & Solheim (1936) approach this type.

In all these cases, modern means of communication has removed the need for signalling with wooden horns. Their survival into the present depends solely on their status as traditional instruments arousing some national pride (Fig. 5), the special sound produced, and the sheer beauty of well-made objects. Modern *lurs* are also used by some players of folk music.

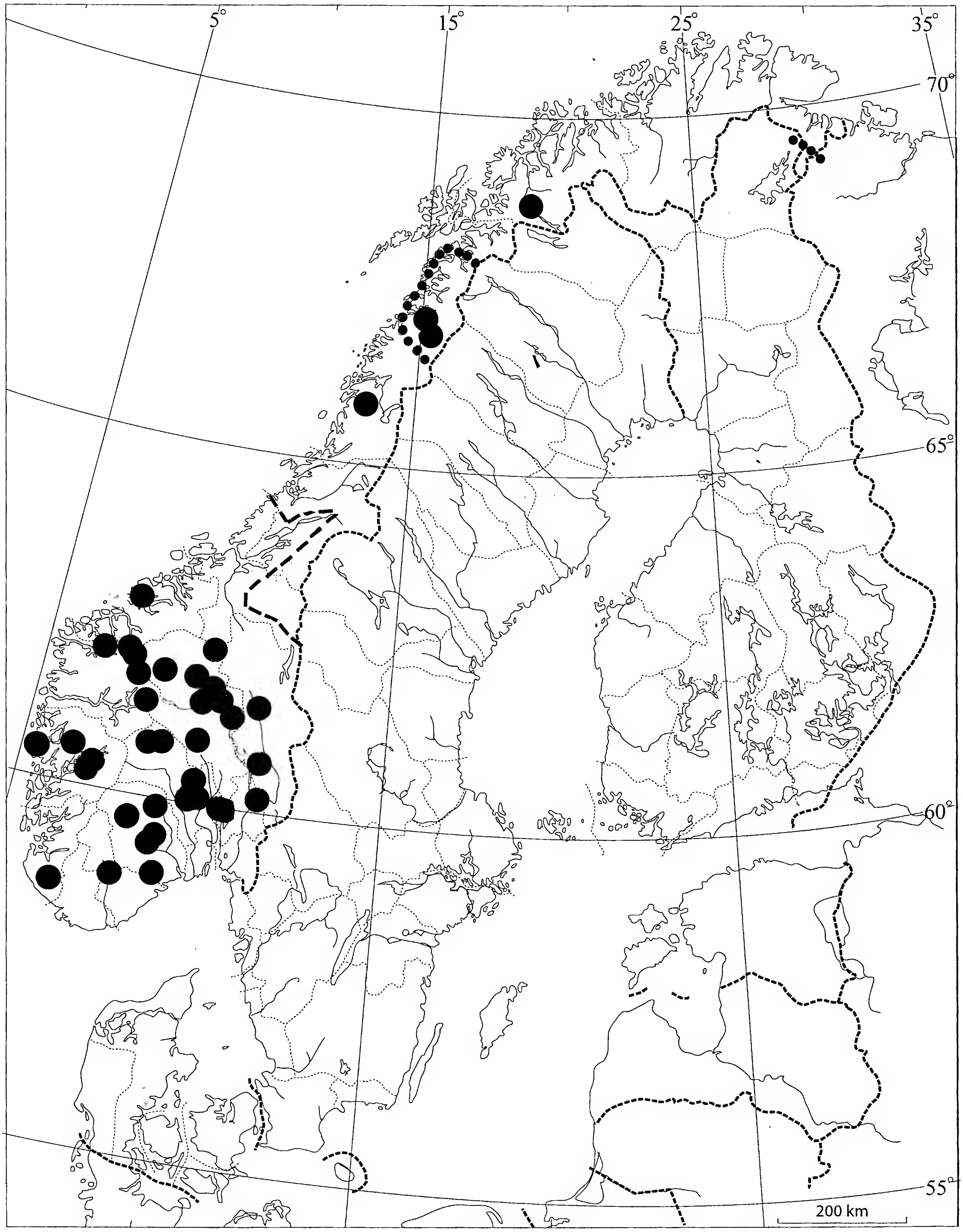

Fig. 4. Map showing geographical distribution of the Norwegian wooden horns mentioned in text. The approximate northern limit of *Betula pendula* as a common feature of lowland forests is indicated by a hatched line, and two disjunct, northern areas of *B. pendula* var. *lapponica* by dotted lines.

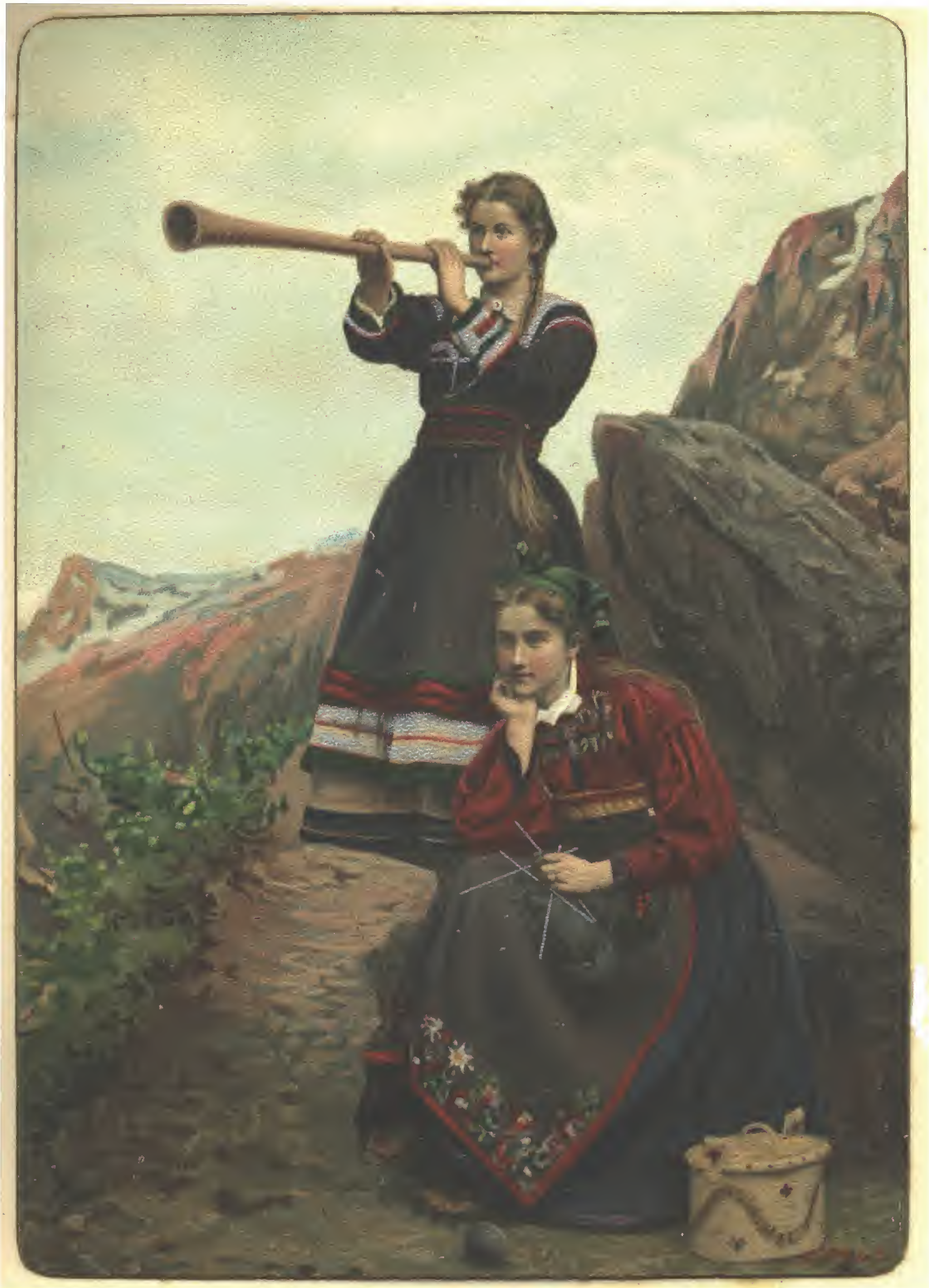

Fig. 5. Early 20th-century postcard showing two Norwegian females in national costumes, one knitting and the other blowing a *lur*.

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# FIRST COLLECTION OF *MICONIA ALAINII* (MELASTOMATACEAE: MICONIEAE) WITH FLOWERS

**Walter S. Judd**

*Department of Biology, 220 Bartram Hall, and*
*Florida Museum of Natural History*
*University of Florida*
*Gainesville, Florida 32611, U.S.A.*
*lyonia@ufl.edu*

**Teodoro Clase**

*Jardín Botánico National Dr. Rafael M. Moscoso*
*Apartado 21-9*
*Santo Domingo, REPÚBLICA DOMINICANA*
*ted_clase@hotmail.com*

**Lucas C. Majure**

*Department of Research, Conservation, and Collections*
*Desert Botanical Garden, 1201 North Galvin Parkway*
*Phoenix, Arizona 85008, U.S.A.*
*lmajure@dbg.org*

## ABSTRACT

*Miconia alainii*, a species previously known only from specimens in vegetative condition or with immature fruits, is now known from flowering material collected by the second author in the Sierra de Baoruco, Dominican Republic. A revised description of this species, including previously unknown floral characters, is presented.

KEY WORDS: Dominican Republic, Sierra de Baoruco, *Miconia alainii*, *Miconia* sect. *Chaenopleura*, Melastomataceae

## RESUMEN

*Miconia alainii* es una especie previamente conocida solo de material en condición vegetativa o con frutos inmaduros, ahora es conocida de un material con flores que fue colectado por el segundo autor en la Sierra de Baoruco, República Dominicana. Se presenta una descripción revisada de esta especie en la que se incluyen los caracteres florales antes no conocidos.

*Miconia alainii* Judd & Skean (Miconieae: Melastomataceae) is a poorly collected species that is endemic to the moist montane forests of the easternmost peak of the Sierra de Baoruco, a location usually referred to as "Monteada Nueva" in reference to a nearby coffee finca, but the region actually occupies the summit of Loma Trocha de Pey (Judd & Skean 1994, Judd 2007). A recent collection of this species by the second author (i.e., *Clase 8037*, see below) from this locality represents the first collection of this species with flower buds and open flowers – the species was previously known only from the type collection (*Liogier 25179*), which has immature fruits, and a second gathering (*Judd 6569*), which is in vegetative condition (and is also a voucher for DNA-material in silica).

To this point the species has been only provisionally placed within *Miconia* sect. *Chaenopleura* because the putative morphological synapomorphies for that section (as represented in the Greater Antilles) are entirely reproductive: an actinomorphic androecium of erectly held, obovate anthers that open by two longitudinal slits, exposing the contents of the four locules, and pale blue berries (see Judd 2007). None of these morphological characteristics have been available for this species until now. However, the stamens of *Clase 8037* are perfectly characteristic of section *Chaenopleura*: obovate with two longitudinal slits running nearly their entire length. There can be no doubt, therefore, that this species belongs in section *Chaenopleura,* which constitutes a large and morphologically diverse group in the Greater Antilles (Judd 2007). This phylogenetic placement is also supported by molecular data (F. Michelangeli, unpublished) since DNA nucleotide sequences derived from *Judd 6567* have been included in a phylogenetic analysis of Miconieae, and in this unpublished analysis *M. alainii* is placed with other species of this clade.

Morphologically *Miconia alainii* appears to be quite isolated among the Greater Antillean species of *Miconia* section *Chaenopleura*. It is anatomically nearly unique in having the spongy mesophyll of its leaf blades strongly lignified (Judd 2007), and it lacks the suites of potential synapomorphies of the nine major infrasectional clades outlined in the monograph of the group (Judd 2007). Like members of the bullate-leaved clade it has cordate-based leaves with six secondary veins and the abaxial leaf surface with quaternary veins consistently raised and prominent. However, it lacks the prominently thickened nodal lenticels, bullate adaxial leaf surface, and rounded cymes characteristic of this group, which includes species such as *M. favosa* (Desr.) Naudin, *M. xenotricha* Urb. & Ekman, *M. howardiana* Judd, Salzman & Skean, and *M. sintenisii* Cogn. Preliminary phylogenetic analyses (still unpublished) based upon DNA-sequence data also suggest that it is not closely related to these species. It may be a fairly early divergent member of Antillean sect. *Chaenopleura*.

This new material allows us to present here an updated and much more complete description of *Miconia alainii*. The description follows the format of Judd (2007) except that the structures here called calyx teeth were in Judd (2007) called external calyx lobes. The structures here called calyx lobes were referred to as internal calyx lobes in Judd (2007). In addition, we have specified in the description the condition of both the crown and the collar at the ovary apex.

## DESCRIPTION OF *MICONIA ALAINII* (SEE ALSO JUDD 2007)

Shrub to 3 m tall. Indumentum of darkly ferrugineous, globular-stellate to irregularly branched or elongate short-branched hairs, and minute-globular hairs. Young twigs not ridged, ± rectangular in cross section, becoming terete with age, the indumentum dense, of darkly ferrugineous, elongate short-branched to globular-stellate hairs, these ± persistent; internodes 1.4–10 (–15) cm long. Leaves with petiole 1.5–7.5 cm long, the indumentum same as that of twigs; blade 4–16 cm long, 3.7–10.5 cm wide, ovate to elliptic, flat, coriaceous, the apex acuminate or shortly acuminate, the base cordate, the margin plane, entire to sparsely and very shallowly dentate distally, 0–70% of margin entire, the largest teeth 0.1–1.4 mm long; venation acrodromous, slightly suprabasal, with prominent midvein and 6 secondary veins, with 4 conspicuous secondary veins, the inner pair placed 5–23 mm in from margin and the outer pair placed 1.3–5 mm in from margin, and 2 inconspicuous secondary veins closer to margin, and numerous percurrent tertiary veins, oriented subperpendicular to midvein, jointed by percurrent-orthogonal quaternary veins; adaxial surface green, the indumentum initially dense globular-stellate, but quickly glabrescent, the midvein and secondary veins slightly impressed, other veins ± flat, the surface appearing only very slightly wrinkled after drying, with sparse druse crystals; abaxial surface light green, sparsely to moderately ferrugineous, globular-stellate to elongate short-branched hairs to 0.1–0.25 mm across, along with minute-globular hairs on midvein and major secondary veins, such hairs very sparse to sparse on minor secondary, tertiary, and higher order veins, the hairs ± persistent and epidermis clearly visible, the midvein and major secondary veins prominently raised, minor secondary, tertiary and quaternary veins raised, higher order veins slightly raised to flat. Inflorescences many-flowered, open-paniculate cymes of 3–5 major branch pairs, ca. 5–6.5 cm long, 4–5 cm in diameter; proximal segment of lowermost inflorescence branches 0.8–1.2 cm long, distal internodes of inflorescence branches increasingly shorter, ultimate branches 1–9 mm long; moderate ferrugineous, globular-stellate hairs, and minute-globular hairs; peduncle 1.5–1.9 cm long, with similar indumentum; each inflorescence branch associated with an early caducous, ovate to ovate-triangular bract, ca. 1.3–4 mm long, 0.5–1 mm wide, the apices acute; flowers in dichasia, each subtended by 2 caducous bracteoles, ca. 1–1.5 mm long, 0.25–0.4 mm wide, narrowly triangular to ± linear, nearly glabrous, with acute apices. Flowers sessile or nearly so, the pedicel 0–1 mm long. Hypanthium cylindrical, free portion 0.5–0.8 mm long, the outer surface with sparse to moderate, ferrugineous, globular-stellate hairs and a few minute-globular hairs, the inner surface glabrous and obscurely 10-ridged, and apices of the ridges slightly projecting. Calyx teeth 5, 0.3–0.9 mm long, 1–1.7 mm wide, triangular, with acute apex, indumentum of moderate stellate-globular hairs; calyx lobes 5, 0.3–0.7 mm long, 1–1.7 mm wide, broadly triangular, with very sparse stellate-globular hairs, with acute to rounded apex, the margin entire; calyx tube 0.3–0.4 mm. Petals 5, 2.4–2.5 mm long, ca. 1.5 mm wide, broadly ovate to elliptic, ± cupped, glabrous, imbricate and apically interlocking in bud, the apex rounded and with an asymmetrically located notch; margin entire. Stamens 10, geniculate, positioned in a ring around the flower, thus androecium actinomorphic, with the filaments flexed back and the anthers held erectly; proximal segment 1.8–2 mm long; distal segment 2–2.3 mm long, with minute dorsal projection on the back of the anther, the anther obovate, 1–1.2 mm long, opening by 2 longitudinal slits, with fertile portion of anther sacs 0.9–1 mm long, the connective/distal part of filament extended 0.8–1 mm beyond the base of the anther. Ovary 3-loculate, 2/3-inferior, 2–2.8 mm long, 1.5–2.4 mm in diameter, globose to ovoid, glabrous and ridged distally, with fluted apical projection (collar) to 0.5 mm encircling the base of style, but crown absent; style ca. 3.3 mm long, straight, glabrous; stigma truncate. Berries (immature) ca. 3.5 mm in diameter, globose, green with red tinge (but probably blue and slightly larger at maturity), with sparse to moderate stellate-globular and minute-globular hairs. Seeds 0.7–1 mm long, angular-obovoid, with a prominent raphe; testa smooth.

Voucher specimens: **DOMINICAN REPUBLIC. Prov. Barahona:** Sierra de Baoruco, Municipio Polo, lugar denominado Cortico, bosque nublado, fragmentado, con *Brunellia comocladifolia*, *Prestoea montana*, *Schefflera tremula*, *Meliosma impressa*, *Cyathea* sp., *Alsophila* sp., etc. UTM265039mEm 2003784mN, elev. 1374 m, 30 Jun 2013 (fl), *T. Clase 8037, with J.R. Martínez, R. Cámara and I. Santos* (FLAS, JBSD); Sierra de Baoruco, Loma Trocha de Pey or "Monteada Nueva," above (E of) Polo, 18 May 1992 (sterile) *W.S. Judd 6569* (F, FLAS, JBSD, MO, NY, US); Barahona: Sierra de Baoruco, Caña Brava, Monteada Nueva, 1300 m, 24 Apr 1976 (young fr), *A.H. Liogier 25179* (holotype: JBSD).

It is perhaps surprising that some Antillean species have to this point not been collected in flowering condition, as the Greater Antilles are considered to be fairly well collected. However, this is unfortunately not that uncommon, and for example flowers are still unknown for the recently described *Miconia cineana* Majure, Judd, Ionta & Skean (Majure et al. 2014) and *Miconia abscondita* Majure, Judd & Skean (Judd et al. 2015), two rare endemics to the southern mountains of Hispaniola (Massif de la Hotte, Haiti) that were described with the combination of DNA sequence and vegetative morphological data, and flowering material was only collected in 2013 by Eldis Bécquer and Fabian Michelangeli (pers. comm.) of a related species (Judd 2007), *Miconia turquinensis* Urb. & Ekman, of the Sierra Maestra, Cuba. Another very rare species in *Miconia* sect. *Lima* has yet to be described from the Massif de la Hotte, as fertile material will be necessary to distinguish it from close relatives (Majure et al. unpubl. data). Finally, *Miconia alloeotricha* (Urb.) Judd, Penneys & Skean, another endemic to the Massif de la Hotte, was described by I. Urban on the basis of specimens with very young inflorescences in 1929, and was only collected with mature flowers and fruits in 1989 and 1993 (Judd et al. 2004).

## ACKNOWLEDGMENTS

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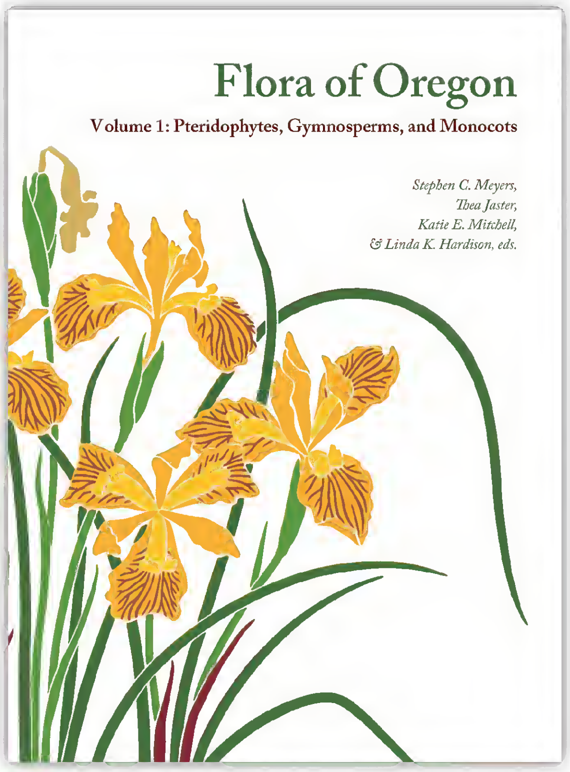
# BOOK NOTICE

Stephen C. Meyers, Thea Jaster, Katie E. Mitchell, & Linda K. Hardison, eds. 2015. **Flora of Oregon, Volume 1: Pteridophytes, Gymnosperms, and Monocots.** (ISBN: 978-1-889878-46-1, hbk). Botanical Research Institute of Texas Press, Fort Worth, Texas 76107, U.S.A. (**Orders:** shop.brit.org, orders@brit.org, 1-817-332-4441). $75.00, 608 pp., 7.5" × 10.5".


Flora of Oregon
Volume 1: Pteridophytes, Gymnosperms, and Monocots
Stephen C. Meyers,
Thea Jaster,
Katie E. Mitchell,
& Linda K. Hardison, eds.

*From the Publisher*—The Oregon Flora Project, Oregon State University, and Botanical Research Institute of Texas Press have collaborated to publish the *Flora of Oregon,* the first comprehensive flora of Oregon in over 50 years—with illustrations!

*Flora of Oregon* is a three-volume reference that will be the state's only flora published in the past half century and the first illustrated floristic work that exclusively addresses Oregon. Volume 1 presents treatments of the pteridophytes, gymnosperms, and monocots—1,054 taxa, or 23% of all native and naturalized vascular plants of Oregon. The taxonomic treatments include dichotomous keys, family and generic synopses, full taxon descriptions, and illustrations. A dot map depicting vouchered occurrences and highlighted ecoregions that host the taxon accompanies each description. There are pen and ink illustrations of 521 taxa, including 86 new works by artist John Myers.

Color photographs accompany chapters describing the state's ecology and sites for exploring botanical diversity. Also included are biographical sketches of notable Oregon botanists and appendices emphasizing plant taxa of interest to conservationists.

A valuable reference for land managers, policy-makers, naturalists, wildflower enthusiasts, historians, teachers, and students of all ages, the Flora of Oregon is a welcome resource for all who appreciate the natural beauty and biodiversity of Oregon.

# ASTERACEAE EN EL DURAZNO Y CERCANÍAS, NORTE DE TAMAZULA, DURANGO (MÉXICO): RIQUEZA, DISTRIBUCIÓN Y ENDEMISMO

**David Ramírez Noya y Yolanda Herrera Arrieta***

*IPN CIIDIR Durango*
*Sigma 119, Fracc. 20 de Noviembre II*
*Durango, Dgo., MÉXICO 34220*
**yolah54@gmail.com*

## RESUMEN

Se estudió la flora de asteráceas y su nivel de endemismo en las cercanías de la comunidad El Durazno, al norte del municipio de Tamazula, Durango, México, en localidades de difícil acceso y escasamente exploradas de la Sierra Madre Occidental. Se realizaron recorridos y recolectas de material botánico en las cuatro estaciones del año, en el periodo de 2001 a 2014. La riqueza florística encontrada de la familia Asteraceae es de 75 géneros y 148 especies, de ellas 51% son especies endémicas de México. Se reportan 17 nuevos registros para el estado de Durango y un endemismo a nivel estatal de 50.33% de géneros y 25.75% de especies. Las principales comunidades vegetales de la región estudiada se encuentran en altitudes de entre 670 y 2550 m y están representadas por bosque de coníferas (2050 a 2550 m) donde se encontró un 49.34% de las asteráceas registradas en este estudio, bosque de encino-pino (1500–1900 m) con un 39.47% de especies y bosque tropical caducifolio (600–1000 m) con un 22.37%, por lo que se concluye que la mayor riqueza florística de esta familia se presenta en el ecosistema templado subhúmedo. De acuerdo con el origen de los taxa, 96% de los géneros y 95.27% de las especies son autóctonos y el resto son exóticos. Se registra también un 27.7% de riqueza de especies sinantrópicas.

PALABRAS CLAVE: Asteraceae, Durango, endemismos, nuevos registros

## ABSTRACT

We studied the Asteraceae flora and its level of endemism in the vicinity of the community El Durazno, northwest of the municipality Tamazula, Durango, Mexico. The locations are difficult to access and are poorly explored areas in the Sierra Madre Occidental. Field trips were conducted to collect botanical material in all four seasons of the year from 2001 to 2014. The floristic richness of the Asteraceae family consisted of 75 genera and 148 species, of which 51% are endemic to Mexico. We report 17 new records for the State of Durango. Endemism is high with 50.33% of genera and 25.75% of species. The main plant communities of the region are found at altitudes between 670 and 2550 m and are represented by: 1) coniferous forest (2050 to 2550 m) where 49.34% of the Asteraceae were recorded in this study; 2) *Pinus-Quercus* forest (1500–1900 m) with 39.47% of species; and 3) deciduous tropical forest (600–1000 m) with 22.37%. It can be concluded that the richest area for this family occurs in the subhumid temperate ecosystem. Accordingly, 96% of genera and 95.27% of species are native, and the rest are exotic. Some 27.7% of the Asteraceae taxa are synantropic species.

KEY WORDS: Asteraceae, Durango, endemism, new records

## INTRODUCCIÓN

Las especies endémicas se distribuyen de forma irregular en la superficie terrestre. Un taxón endémico se define como "aquel que restringe su distribución a una región específica" (Suárez-Mota y Villaseñor 2011), representando la fracción exclusiva de su riqueza biológica. La determinación de las áreas ricas en endemismos es importante para los estudios biogeográficos históricos, ya que dichas áreas se constituyen como probables sitios de origen y diversificación de grupos florísticos (Rzedowski 1991b).

Villaseñor (2003) considera a México como uno de los primeros cinco países megadiversos por su riqueza florística y alto nivel de endemismo en su flora. El endemismo de la flora de México ha sido estudiada a nivel nacional, estatal y regional; Rzedowski (1991a) estima un 52% de endemismo en México, mientras que Villaseñor (2003) estima un 65.9%. A nivel estatal los estudios son escasos, resaltan los de Balleza y Villaseñor (2002) para Zacatecas, Castillo-Campos et al. (2005) para Veracruz o Suárez-Mota y Villaseñor (2011) para Oaxaca. El endemismo también se discute en trabajos realizados a nivel regional, como los de Hernández-L. (1995) en la Sierra de Manantlán, Jalisco-Colima; Méndez et al. (2004) en el Valle de Tehuacán-Cuicatlán, Puebla-Oaxaca o el de Hinojosa-Espinosa y Cruz-Durán (2010) en el municipio de Atenango del Río, Guerrero, entre otros.

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La familia de las Compuestas o Asteraceae, es una de las mejor representadas a nivel mundial dentro de las plantas con flor (Magnoliophyta), dado que se estima que cuenta con 1,535 géneros y aproximadamente 23,000 especies (Bremer 1994). De acuerdo con Rzedowski (1991b) es la familia más diversa en México, con aproximadamente 314 géneros y 2,400 especies (52% de endemismos); posteriormente Villaseñor (2003) estimó que existen 361 géneros y 3,021 especies (65.9% de endemismo) de Asteraceae a nivel nacional. Ambos autores resaltan que en México se concentra una riqueza elevada de especies de Asteraceae, cuando se compara con otras regiones del mundo, por lo que proponen que podría ser su principal centro de diversificación. Adicionalmente Villaseñor (2003) indica que Asteraceae es la familia de fanerógamas con el más alto porcentaje de endemismo en México, en este sentido, llevar a cabo más estudios a nivel estatal y regional contribuirá a confirmar dicha teoría y a conocer más su distribución florística en el país.

Las Compuestas se desarrollan principalmente en climas templados y secos, la mayoría de ellas como especies nativas de los ecosistemas que habitan (Rzedowski 1972; Villaseñor 1993); sin embargo, un alto porcentaje de especies de asteráceas se ve favorecida por la perturbación (flora sinantrópica), por lo que suelen ser dominantes en medios arvenses y/o ruderales (Villaseñor 2012). A la fecha son escasos los estudios de la diversidad de plantas que se distribuyen en la Sierra Madre Occidental, especialmente en sus laderas hacia el Pacífico, por razones complejas como es la combinación de lo accidentado de la sierra, el difícil acceso y la lejanía de centros urbanos, sin mencionar los problemas de inseguridad que aquejan la región. Asi, el objetivo del presente estudio fue contribuir al conocimiento de la riqueza y endemismos de la familia Asteraceae en la región de El Durazno y cercanías, al norte del municipio de Tamazula, Durango, México. El área explorada se ubica en la región de las quebradas, ladera oeste de la Sierra Madre Occidental, al noroeste de Durango (Fig. 1), justo en las proximidades a la convergencia con los estados de Chihuahua y Sinaloa. Se caracteriza por ser particularmente de difícil acceso, motivo por el cual los muestreos de flora y fauna de estas localidades son escasamente conocidas, lo que reforzó la idea de iniciar el presente estudio, esperando encontrar especies endémicas y de ocurrencia escasa o rara.

No existen reportes de estudios florísticos realizados en el área específica del presente estudio. Gómez (2005) establece que los primeros exploradores botánicos en visitar estos rumbos "… viniendo de Álamos, Son., y cruzando la sierra entre Canelas y Topia hacia Tepehuanes …" fueron J.M. Mociño y Juan Diego de Castillo, entre los años de 1791 y 1792, sin embargo no se conoce la existencia de ejemplares de esa expedición que provengan de nuestra área de estudio. Existen registros de ejemplares en los herbarios MBO y US (www.tropicos.org) de colectas realizadas por J. González Ortega entre 1921 y 1922 (compuestas, gramíneas, pottiáceas y bignoniáceas) en el municipio de Tamazula, Durango y por Gentry en 1939 (leguminosas), todas ellas de localidades cercanas a la cabecera municipal de Tamazula, misma que se encuentra a una distancia aproximada de 55 km al sur del área de estudio en línea recta. Así también, encontramos otros estudios realizados en localidades ubicadas en un área geográfica radial a distancias menores de 60 km en línea recta de nuestra área de estudio, como son los de Greenman (1905); Turner (1986); Nesom (1989a, 1989b, 1990, 1992); Panero y Villaseñor (1993), Vega Aviña et al. (2000) y McDonald et al. (2011), quienes mencionan o describen especies que serán comparadas con las registradas en este reporte.

El presente estudio fue realizado en el Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional, Unidad Durango (CIIDIR IPN Durango). El primer autor realizó recorridos de exploración y muestreo en dos tramos (I y II) de la región, a través del tránsito por brechas y veredas, en diferentes meses del año, durante el intervalo del período comprendido entre los años 2001 a 2014; en el marco de estudios de carácter lingüístico, zoológico y botánico que se realizan en el CIIDIR IPN Durango. Concerniente a lo botánico, D. Ramírez N. se enfocó a la familia Asteraceae por interés personal (y de su especialidad) y con el propósito único de contribuir al conocimiento de la biodiversidad de dicha familia en el Estado.

## Área de estudio

El Municipio de Tamazula (Fig. 1) está ubicado al oeste del estado de Durango, colinda con los municipios Guadalupe y Calvo, Chihuahua y Culiacán, Sinaloa. Registra altitudes desde 190 m, en las cercanías a la cabecera municipal, hasta 2900 m en localidad contigua a El Durazno. Las cercanías al Durazno es la región ex-

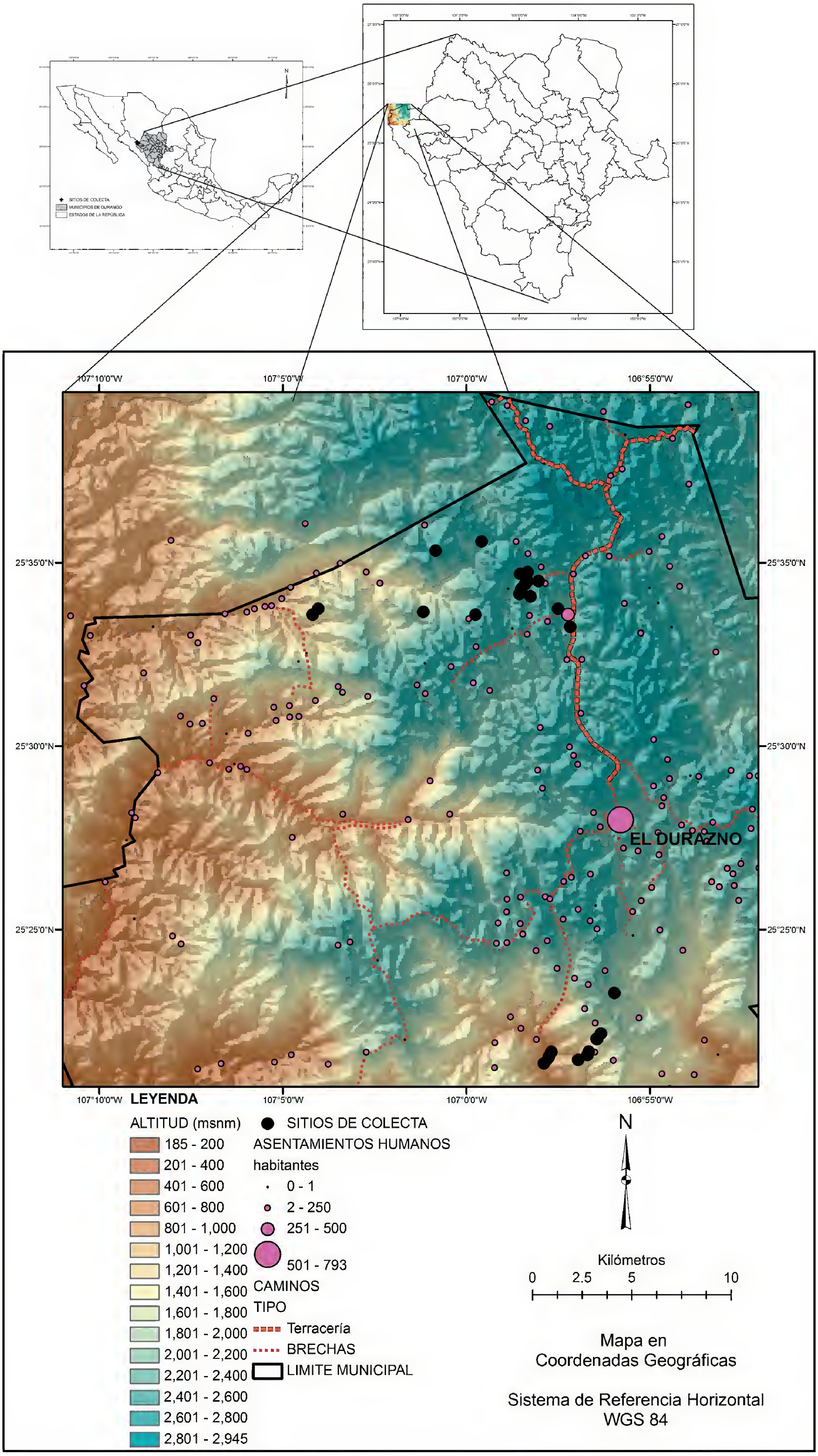
107°10'0"W
107°5'0"W
107°0'0"W
106°55'0"W
25°35'0"N
25°30'0"N
25°25'0"N
EL DURAZNO
LEYENDA
ALTITUD (msnm)
185 - 200
201 - 400
401 - 600
601 - 800
801 - 1,000
1,001 - 1,200
1,201 - 1,400
1,401 - 1,600
1,601 - 1,800
1,801 - 2,000
2,001 - 2,200
2,201 - 2,400
2,401 - 2,600
2,601 - 2,800
2,801 - 2,945
SITIOS DE COLECTA
ASENTAMIENTOS HUMANOS
habitantes
0 - 1
2 - 250
251 - 500
501 - 793
CAMINOS
TIPO
Terracería
BRECHAS
LIMITE MUNICIPAL
N
Kilómetros
0 2.5 5 10
Mapa en
Coordenadas Geográficas
Sistema de Referencia Horizontal
WGS 84

**Fig. 1.** Área de los recorridos en El Durazno y cercanías, al norte del municipio Tamazula, Durango, México.

plorada y recolectada para el presente estudio (Fig. 1), se encuentra ubicada a 55 km al norte en línea recta de la cabecera municipal (Tamazula); es la población más grande de nuestra área de estudio (por lo cual se toma como referencia), cuenta con menos de 800 habitantes. Le sigue en importancia el poblado San Juan del Tecuan, ubicado a 10 km al norte de El Durazno, con menos de 500 habitantes; otros asentamientos humanos son comunidades con menos de 250 habitantes, o bien rancherías de 1 a 10 familias dispersas en el área explorada, en una porción de la "región de las quebradas" de la Sierra Madre Occidental.

Las localidades exploradas en el presente estudio pertenecen a la cuenca del Río Humaya, considerada por la CONABIO como región terrestre prioritaria para su conservación (Clasificación no. RTP24, Río Humaya). El área estudiada cuenta con las siguientes coordenadas extremas: al noroeste 25°33'37"N, 107°04'07"W, a 1512 m sobre el nivel del mar, en la ranchería "El Cordón"; al norte 25°35'21"N, 107°00'42"W, a 2745 msnm, al sur 25°20'20"N, 106°57'05"W, a 669 msnm, próximo al rancho "Santa Matilde"; al este 25°32'24"N, 106°56'58"W a 2383 msnm; y al oeste 25°33'37"N, 107°04'07"W a 2383 msnm. Las comunidades vegetales que comprende (González et al. 2007) son: bosque de coníferas (de extensión restingida) con *Abies durangensis, Pinus strobiformis* y *P. durangensis*, encontrado en altitudes de 2425 a 2550 m en cañadas húmedas; bosque de pino en lomeríos suaves y mesetas, con *Pinus durangensis, P. arizonica, P. leiophyla* y *P. cooperi*, en altitudes de 2026 a 2400 m. Bajando a aproximadamente 1650 m de altitud se encuentra el bosque de pino-encino con *Pinus teocote, P. lumholtzii y Quercus* spp., con la presencia de *Magnolia schiedeana y Juglans* sp. en cañadas húmedas (justo en la localidad La Presa, de los Aguajes). Cerca de 1525 m de altitud se encuentra el bosque de encino *Quercus spp.* y *Bursera* spp., con *Lippia umbellata* y *Montanoa leucantha* bien desarrolladas y muy abundantes en esta comunidad vegetal. Este bosque parece presentar el área de transición entre el ecosistema templado y el tropical, por la presencia de especies de ambos ecosistemas. En las partes más bajas se encuentra el bosque tropical caducifolio, en altitudes de 670 a 1400 m con *Lysiloma acapulcensis, Acacia pennatula, A. farnesiana, Ipomoea arborescens, Stemmadenia tomentosa, Bursera* spp., *Randia* spp. y *Heliocarpus* entre otras, y ya en la parte más baja de las quebradas se encuentra *Ficus* spp., *Cochlospermum vitifolium, Tabebuia* spp., *Acacia* spp. y *Lysiloma* spp. Las principales localidades (áreas de recolección intensa) se presentan en la Tabla 1, sin dejar de recolectar especies diferentes en todo el trayecto.

La descripción de los recorridos se presenta a continuación:

**a). Recorrido del tramo I.—**ubicado en la parte norte-noroeste de la comunidad El Durazno (Fig. 1), el punto de partida generalmente fue del poblado San Juan del Tecuan, Tamazula, Dgo. (25°34'05"N, 106°57'20"W y 2400 m de altitud), donde se realizaron colectas al azar caminando por brechas y veredas temporales y de forma continua en una trayectoria zigzagueante hacia el oeste, que asciende hasta 2550 m de altitud, posteriormente descendiendo a la ranchería Aguazul, a 1590 m de altitud; esto con el fin de muestrear la mayor superficie posible. Los recorridos representaron, un total aproximado de 60 km, comprendiendo el bosque de coníferas (*Abies durangensis, Pinus strobiformis* y *P. durangensis*), bosque de pino (*Pinus durangensis, P. leiophyla* y *P. cooperi*), hasta el ecotono con el bosque tropical caducifolio. Se reunieron en este tramo un total de 388 registros de ejemplares recolectados, de los que un número reducido corresponden a ejemplares de fauna silvestre.

**b). Recorrido del tramo II.—**se llevó a cabo al sur de la comunidad El Durazno (Fig. 1). Esta segunda ruta de exploración se realizó a partir de las proximidades de La Ranchería San Darío (25°22'36"N, 106°55'18"W y 1837 m de altitud), transitando con rumbo oeste-sureste, hasta la parte baja de la Quebrada Camarones, 25°21'40"N, 106°57'41"W, llegando a bajar hasta 670 m de altitud, en el arroyo Camarones. Las recolectas se realizaron básicamente siguiendo las brechas y veredas temporales que permiten acceso a pie o con el apoyo de animales, ya que lo abrupto del terreno limitó efectuar caminatas direccionadas. El transecto cubre un total aproximado de 40 km de recorrido, en comunidades vegetales de bosque de pino (*Pinus durangensis*, *P. lumholtzii*), pino-encino (*Pinus teocote, Quercus* spp.), a bosque tropical caducifolio de *Lysiloma acapulcensis, Acacia* spp., *Bursera* spp. y *Ficus* spp. Se reunieron en este tramo un total de 472 registros de ejemplares recolectados, y al igual que en el Tramo I, un número reducido de ellas corresponde a ejemplares de fauna silvestre.

Tabla 1. Localidades muestreadas y taxa encontrados en las cercanías de El Durazno, Tamazula, Durango, México.

*Acmella radicans* (Jacq.) R.K. Jansen. Predio La Presa, Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'27"W, 8 nov 2001, bosque de *Quercus* sp., *Magnolia* sp., *Bursera* sp., 1525 m, *D. Ramírez Noya 2077* (CIIDIR). Arroyo Camarones, Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'40"N, 106°57'41"W, 28 may 2002, bosque tropical caducifolio de *Lysiloma* spp., *Acacia* spp., *Bursera* spp. y *Ficus* spp., 710 m, *D. Ramírez Noya 2195* (CIIDIR).

*Acmella repens* (Walter) Rich. Sta Matilde, Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'21"N, 106°57'53"W, 24 may 2003, bosque tropical caducifolio de *Lysiloma* spp., *Acacia* spp., *Bursera* spp. y *Ficus* spp., 670 m, *D. Ramírez Noya 2362* (CIIDIR).

*Acourtia macrocephala* Sch. Bip. Los Bajíos, El Tecuán, Tamazula, Dgo., 25°33'15"N, 106°57'10"W, 20 sep 2008. Llanura entre el bosque de pino, 2425 m, *D. Ramírez Noya 2995* (CIIDIR).

*Adenophyllum anomalum* (Canby & Rose) Sthrother. Próximo al arroyo Camarones, Los Aguajes, El Durazno, Tamazula, Dgo. 25°21'46"N, 106°57'40"W, 11 dic 2014, bosque tropical caducifolio, 809 m, *D. Ramírez Noya 4275* (CIIDIR).

*Adenophyllum cancellatum* (Cass.) Villarreal. Camino a El Caballete, Los Aguajes, El Durazno, Tamazula, Dgo. 25°22'08"N, 106°56'52"W, 8 oct 2014, bosque de *Quercus* sp. 1481 m. *D. Ramírez Noya* 4100 (CIIDIR).

*Adenophyllum porophyllum* (Cav.) Hemsl., orilla de camino, Los Aguajes, El Durazno, Tamazula, Dgo. 25°22'01"N, 106°56'26"W, 9 nov 2001, bosque de *Pinusteocote, P. lumholtzi y Quercus* spp., 1520 m, *D. Ramírez Noya 2138* (CIIDIR).

*Ageratina hederifolia* (A. Gray) R.M. King & H. Rob. Cerro Alto, El Tecuán de El Durazno, Tamazula, Dgo., 25°35'20"N, 107°00'50"W, bosque de *Abies durangensis*, *Pinus durangensis, P. strobifrmis,* 28 jun 2005, 2550 m, *D. Ramírez Noya 2691* (CIIDIR). La Aguateca, El Tecuan, El Durazno, Tamazula, Dgo., 25°35'35"N, 106°59'35"W, bosque de *Pinus durangensis, P. strobiformis, P. arizonica*, 2450 m, 9 abr 2013, *D. Ramírez Noya 3809* (CIIDIR).

*Ageratina choricephala* (B.L. Rob.) R.M. King & H. Rob. Predio La cañada. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'27"W, 8 nov 2001, bosque de *Quercus* sp., *Magnolia* sp., *Bursera* sp., 1525 m, *D. Ramírez Noya 2075*, *2426* (CIIDIR).

*Ageratina malacolepis* (B.L. Rob.) R.M. King & H. Rob.Arroyo Camarones, Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'32"N, 106°57'45"W, 23 may 2003, bosque tropical caducifolio de *Lysiloma* spp., *Acacia* spp., *Bursera* spp. y *Ficus* spp. 715 m, *D. Ramírez Noya 2361, 2792* (CIIDIR).

*Ageratina palmeri* (A. Gray) Gage ex B.L. Turner. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'10"N, 106°56'20"W, 15 oct 2003, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp*., 1650 m, *D.Ramírez Noya 2478* (CIIDIR).

*Ageratina pazcuarensis* (Kunth) R.M. King & H. Rob. La Aguateca, El Tecuán, El Durazno, Tamazula, Dgo., 25°33'35"N, 106°59'45"W, bosque de *Pinus durangensis, P. arizonica*, 3 abr 2008, 2250 m, *D. Ramírez Noya 2791* (CIIDIR). San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'09"N, 106°58'33"W, bosque de *Pinus durangensis, P. strobiformis*, 10 jun 2008, 2454 m, *D. Ramírez Noya 2841* (CIIDIR).

*Ageratum corymbosum* Zucc. f. *corymbosum*. Potreritos, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'17"N, 106°58'30"W, 21sep 2008, bosque de pino abierto2435 m, *D. Ramírez Noya 3043* (CIIDIR).

*Ageratum corymbosum* f. *euryphyllum* (B.L. Rob.) M.F. Johnson. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 13 oct 2003, bosque de *Pinus teocote, P. lumholtzi y Q.* spp., 1520 m, *D. Ramírez Noya 2433* (CIIDIR).

*Alloispermum palmeri* (A. Gray) C.F. Fernández & Urbatsch. El tabacal, El Guajolote, El Tecuan, Tamazula, Dgo., 25°33'45"N, 107°04'02"W, 24 jun 2009, bosque de encino, 1600 m, *D. Ramírez Noya 3120* (CIIDIR).

*Ambrosia ambrosioides* (Cav.) W.W. Payne. Sta Matilde, Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'21"N, 106°57'53"W, 24 may 2003, bosque tropical caducifolio de *Lysiloma spp*., *Acacia spp*., *Bursera* spp. y *Ficus spp*., 670 m, *D. Ramírez Noya 2369* (CIIDIR).

*Artemisia ludoviciana* Nutt. La Aguateca, El Tecuán, El Durazno, Tamazula, Dgo., 25°33'35"N, 106°59'45"W, bosque de *Pinus durangensis, P. arizonica*, 3 abr 2008, 2250 m, *D. Ramírez Noya 2803* (CIIDIR).

*Baccharis multiflora* Kunth var. *herbacea* McVaugh. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'08"N, 106°56'52"W, 8 oct 2014, bosque de *Pinus* spp. y *Quercus spp*., 1481 m, *D. Ramírez Noya 4098* (CIIDIR).

*Baccharis pteronioides* DC. próximo a El Cordón, El Aguaje, El Durazno, Tamazula, Dgo., 25°21'50" N, 106°55'50"W, 10 oct 2014, bosque de *Pinus teocote, P. lumholtzi y Quercus* spp., 1790 m, *D. Ramírez Noya 4212* (CIIDIR).

*Baccharis salicifolia* (Ruiz & Pav.) Pers. Cerca a San Dario-Aguajes, 25°23'16"N, 106°55'58"W, 12 oct 2003, bosque de *Pinus durangensis y P. strobiformis,* 2071 m, *D. Ramírez Noya2406* (CIIDIR).

*Barkleyanthus salicifolius* (Kunth) H. Rob. & Brettell. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'42"N, 106°58'32"W, 22 ago 2008, bosque de *Pinus durangensis, P. strobiformis, P. arizonica*, 2455 m, *D. Ramírez Noya 2935* (CIIDIR).

*Bidens aurea* (Aiton) Sherff. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'45"N, 106°58'20"W, 21 ago 2008, Llanura entre el bosque de pino, 2450 m, *D. Ramírez Noya 2973*, *3953* (CIIDIR).

*Bidens bigelovii* A. Gray. Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'40"N, 106°56'40"W, 14 oct 2003, bosque tropical caducifolio, 1400 m, *D. Ramírez Noya 2459,2483* (CIIDIR).

*Bidens lemmonii A.* Gray. El Tecuán, Tamazula, Dgo., 25°33'45"N, 106°57'30"W, 20 sep 2008, bosque de pino abierto, 2425 m, *D. Ramírez Noya 3009,3015* (CIIDIR).

*Bidens ostruthioides* (DC.) Sch. Bip. Potreritos, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'17"N, 106°58'30"W, 21 sep 2008, bosque de pino abierto, 2435 m, *D. Ramírez Noya 3042* (CIIDIR).

*Bidens pilosa* L. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'10"N, 106°56'20"W, 15 oct 2003, bosque de *Pinus teocote, P. lumholtzii y Quercus spp*., 1650 m, *D. Ramírez Noya 2485* (CIIDIR).

*Bidens riparia* Kunth. El Rincón, Los Aguajes, El Durazno, Tamazula, Dgo. 25°21'33"N, 106°57'07"W, 8 oct 2014, bosque tropical caducifolio, 978 m, *D. Ramírez Noya 4147* (CIIDIR).

*Bidens tenuisecta* A. Gray. El Tecuán, Tamazula, Dgo., 25°33'45"N, 106°57'30"W, 20 sep 2008, bosque de pino abierto. 2425 m, *D. Ramírez Noya 2996* (CIIDIR).

*Brickellia diffusa* (Vahl) A. Gray. Próximo a El Caballete, Los Aguajes, El Durazno, Tamazula, Dgo. 25°22'02"N, 106°56'55"W, 8 oct 2014, bosque de *Quercus* spp. 1455 m, *D.Ramírez Noya 4115* (CIIDIR).

Tabla 1. (continued)

*Brickellia filipes* B.L. Rob. Próximo a El Caballete, Los Aguajes, El Durazno, Tamazula, Dgo. 25°22'02"N, 106°56'55"W, 8 oct 2014, bosque de *Quercus* sp. 1481 m, *D. Ramírez Noya 4116* (CIIDIR).

*Brickellia oliganthes* (Less.) A. Gray. Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'27"N, 106°56'57"W, 14 oct 2003, bosque tropical caducifolio, 1100 m, *D. Ramírez Noya 2472*(CIIDIR).

*Brickellia oreithales* (B.L. Rob) Shinners. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'45"N, 106°58'20"W, 21 ago 2008, Llanura en el bosque de pino, 2450 m, *D. Ramírez Noya2845* (CIIDIR). El Tecuán, Tamazula, Dgo., 25°33'45"N, 106°57'30"W, 20 sep 2008, bosque de pino abierto, 2425 m, *D. Ramírez Noya 2997* (CIIDIR).

*Brickellia secundiflora* (Lag.) A. Gray. orilla de camino, Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 9 nov 2001, bosque de *Pinus teocote, P. lumholtzii* y *Quercus spp*., 1520 m, *D. Ramírez Noya 2153*(CIIDIR).

*Brickellia subuligera* (S. Schauer) B.L. Turner. La gentilera, Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'41"N, 106°57'08.3"W, 8 oct 2014, bosque tropical caducifolio, 1090 m, *D. Ramírez Noya 4129* (CIIDIR).

*Carminatia tenuiflora* DC. Predio; La Presa. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'27"W, 8 nov 2001, bosque de *Quercus* sp., *Magnolia sp., Bursera sp.,* 1525 m, *D. Ramírez Noya2074* (CIIDIR).

*Centaurea rothrockii* Greenm. Corral de Piedra, El Tecuan, El Durazno, Tamazula, Dgo., bosque de pino abierto. 25°34'25"N, 106°58'24"W, 21 ago 2008, 2435 m, *D. Ramírez Noya 2913*, *2959* (CIIDIR).

*Chaptalia runcinata* Kunth. Corral de Piedra, El Tecuan, El Durazno, Tamazula, Dgo., bosque de pino abierto, 25°34'25"N, 106°58'24"W, 21 ago 2008, 2435 m, *D. Ramírez Noya2905*, *3984* (CIIDIR).

*Chloracantha spinosa* (Benth.) G.L. Nesom var. *jaliscensis* (McVaugh) S.D. Sundb. Sta Matilde, Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'21"N, 106°57'53"W, 24 may 2003, bosque tropical caducifolio de *Lysiloma* spp., *Acacia* spp., *Bursera* spp. y *Ficus* spp., 670 m, *D. Ramírez Noya 2365* (CIIDIR).

*Chromolaena collina* (DC.) R.M. King & H. Rob. Predio La Presa, Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'27"W, 8 nov 2001, bosque de *Quercus* sp.*, Magnolia* sp., *Bursera* sp., 1525 m, *D. Ramírez Noya 2086* (CIIDIR).

*Chromolaena odorata* (L.) R.M. King & H. Rob. Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'32"N, 106°56'46"W, 11 dic 2014, bosque tropical caducifolio, 1383 m, *D. Ramírez Noya 4281* (CIIDIR).

*Chromolaena ovaliflora* (Hook. & Arn.) R.M. King & H. Rob. Predio La Presa, Los Aguajes, El Durazno, Tamazula, Dgo.,25°22'01"N, 106°56'27"W, 8 nov 2001, bosque de *Quercus* sp., *Magnolia* sp.*, Bursera* sp., 1525 m, *D. Ramírez Noya 2084* (CIIDIR).

*Cirsium ehrenbergii* Sch. Bip. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 22 ago 2008, bosque de *Pinus durangensis, P. strobiformis, P. arizonica*, 25°34'42"N, 106°58'32"W, 2455 m, *D. Ramírez Noya 2954* (CIIDIR).

*Conyza microcephala* Hemsl. Cerca a San Dario-Aguajes, 25°23'16"N, 106°55'58"W, 12 oct 2003, bosque de *Pinus durangensis y P. strobiformis*, 2071 m, *D. Ramírez Noya 2413*, *3978-b* (CIIDIR).

*Coreocarpus arizonicus* (A. Gray) S.F. Blake var. *filiformis* (Greenm.) S.F. Blake. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 10 dic 2014, bosque de *Pinus teocote, P. lumholtzi* y *Quercus* spp., 1520 m, *D. Ramírez Noya 4263* (CIIDIR).

*Coreocarpus congregatus* (S.F. Blake) E.B. Sm. La Presa, Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'27"W, 9 oct 2014, bosque de *Quercus* spp. *Magnolia* sp. *Bursera* sp., 1525 m, *D. Ramíres Noya 4165-c* (CIIDIR).

*Cosmos bipinnatus* Cav. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'45"N, 106°58'20"W, 21 ago 2008, llanura entre el bosque de pino, 2450m, D. Ramírez Noya s/n. El Tecuan, Tamazula, Dgo., 25°33'45"N, 106°57'30"W, 20 sept 2008, terreno abierto en el bosque de pino, 2425m,

*Cosmos palmeri* B.L. Rob. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'45"N, 106°58'20"W, 21 ago 2008, Llanura en el bosque de pino, 2450 m, *D. Ramírez Noya 2849* (CIIDIR).

*Cosmos parviflorus* (Jacq.) Pers. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'45"N, 106°58'20"W, 21 ago 2008, Llanura en el bosque de pino, 2450 m, *D. Ramírez Noya 2850, 2970* (CIIDIR).

*Cosmos sulphureus* Cav. orilla de camino, Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 9 nov 2001, bosque de *Pinus teocote, P. lumholtzi y Quercus spp*., 1520 m, *D. Ramírez Noya2147* (CIIDIR).

*Critonia hebebotrya*DC. orilla de camino, Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 9 nov 2001, bosque de *Pinus teocote, P. lumholtzi y Quercus spp*., 1520 m, *D. Ramírez Noya2125*, *2423* (CIIDIR).

*Critonia quadrangularis* (DC.) R.M. King & H. Rob.Predio La Presa, Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'27"W, 8 nov 2001, bosque de *Quercus* spp.*, Magnolia* sp.*, Bursera* sp.*,* 1525 m, *D. Ramírez Noya 2333* (CIIDIR).

*Critoniopsis triflosculosa* (Kunth) H. Rob. Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'40"N, 106°56'40"W, 30 jun 2005, bosque tropical caducifolio, 1400 m, *D. Ramírez Noya2722* (CIIDIR).

*Dahlia coccinea Cav.* Próximo al Cordón, El Aguaje, El Durazno, Tamazula, Dgo., 25°21'50"N, 106°55'50"W, 10 oct 2014, bosque *Pinus teocote, P. lumholtzi* y *Quercus* spp., 1790 m, *D. Ramírez Noya 4206-b* (CIIDIR).

*Dahlia sherffii* P.D. Sorensen. Corral de Piedra, El Tecuan, El Durazno, Tamazula, Dgo., bosque de pino abierto, 25°34'25" 106°58'24", 21 ago 2008, 2435 m, *D. Ramírez Noya 2877* (CIIDIR).

*Decachaeta ovatifolia* (DC.) R.M. King & H. Rob.Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 13 oct 2003, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp*., 1520 m, *D. Ramírez Noya 2424, 2436* (CIIDIR).

*Decachaeta scabrella* (B.L. Rob.) R.M. King & H. Rob. Predio; La Presa. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'27"W, 8 nov 2001, bosque de *Quercus* spp.*, Magnolia* sp., *Bursera* sp.*,* 1525 m, *D. Ramírez Noya 2072* (CIIDIR).

*Delilia biflora* (L.) Kuntze. Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'40"N, 106°56'40"W, 14 oct 2003, bosque tropical caducifolio, 1400 m, *D. Ramírez Noya 2447* (CIIDIR).

*Erigeron astranthoides* De Jong & G.L. Nesom. Corral de Piedra, El Tecuan, El Durazno, Tamazula, Dgo., bosque de pino, 25°34'25"N, 106°58'24"W, 21 ago 2008, 2435 m, *D. Ramírez Noya 2886, 2910* (CIIDIR).

Tabla 1. (continued)

*Erigeron coroniglandifer* G.L. Nesom. Corral de Piedra, El Tecuan, El Durazno, Tamazula, Dgo., bosque de pino abierto, 25°34'25"N, 106°58'24"W, 21 ago 2008, 2435 m, *D. Ramírez Noya2882* (CIIDIR). El Tecuán, Tamazula, Dgo., 25°33'45"N, 106°57'30"W, 20 sep 2008, bosque de pino abierto, 2425 m, *D. Ramírez Noya 2999* (CIIDIR).

*Erigeron griseus* (Greenm.) G.L. Nesom. Sn Juan, El Tecuan, Tamazula, Dgo., 25°34'30"N, 106°58'20"W, 27 jun 2005, pastoreo en bosque de pino, 2420 m, *D. Ramírez Noya 2648, 2653-b* (CIIDIR).

*Erigeron podophyllus* G.L. Nesom. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 22 ago 2008, bosque de pino (*Pinus durangensis, P. strobiformis, P. arizonica*), 25°34'42"N, 106°58'32"W, 2455 m, *D. Ramírez Noya 2934* (CIIDIR).

*Erigeron polycephalus* (Larsen) Nesom. De amplia distribución, encontrada en casi todas las localidades.

*Erigeron seemannii* (Sch. Bip.) Greene. La Aguateca El Tecuán, El Durazno, Tamazula, Dgo., 25°33'45"N, 106°00'18"W, bosque de pino, 3 abr 2008, (*Pinus durangensis, P. arizonica*), 2026 m, *D. Ramírez Noya 2805* (CIIDIR).

*Erigeron velutipes* Hook. & Arn. *2172, 2804* (CIIDIR). Encontrada en casi todas las localidades.

*Erigeron wislizeni* (A. Gray) Greene. El Tecuán, Tamazula, Dgo., 25°33'45"N, 106°57'30"W, 20 sep 2008, bosque de pino abierto, 2425 m, *D. Ramírez Noya 2999-b* (CIIDIR).

*Fleischmannia sonorae* (A. Gray) R.M. King & H. Rob. Predio La Presa, Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'27"W, 8 nov 2001, bosque de *Quercus* spp.*, Magnolia* sp.*, Bursera* sp.*,* 1525 m, *D. Ramírez Noya 2082, 2441* (CIIDIR).

*Galinsoga parviflora* Cav.orilla de camino, Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 9 nov 2001, bosque de pino-encino (*Pinus teocote, P. lumholtzi* y *Quercus spp.*), 1520 m, *D. Ramírez Noya 2119* (CIIDIR).

*Galinsoga quadriradiata* Ruíz & Pav. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'45"N, 106°58'20"W, 21 ago 2008, Llanura en el bosque de pino, 2450 m, *D. Ramírez Noya 2854* (CIIDIR).

*Gamochaeta americana* (Mill.) Wedd. Corral de Piedra, El Tecuan. El Durazno, Tamazula, Dgo., 25°34'05"N, 106°58'15"W, 16 oct 2013, pastizal inducido, 2435 m, *D. Ramírez Noya 3983-b* (CIIDIR).

*Guardiola rosei* B.L. Rob. En la orilla de caminos, Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 9 nov 2001, bosque de pino-encino *(Pinus teocote, P. lumholtzi y Quercus spp.*), 1520 m, *D. Ramírez Noya 2148, 2839, 2952* (CIIDIR).

*Heterosperma pinnatum* Cav. De amplia distribución, encontrada en casi todas las localidades.

*Heterotheca chihuahuana* B.L. Turner. El Tecuan, El Durazno, Tamazula, Fgo., 25°33'28"N, 106°57'21"W, agostadero en el bosque de *Pinus durangensis, P. strobiformis*, 22 may 2003, 2409 m, *D. Ramírez Noya 2326*(CIIDIR).

*Hieracium fendleri* Sch. Bip. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'09"N, 106°58'33"W, bosque de *Pinus durangensis, P. strobiformis*, 10 jun 2008, 2454 m, *D. Ramírez Noya 2821*(CIIDIR).

*Hieracium schultzii* Fries. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'09"N, 106°58'33"W, bosque de *Pinus durangensis, P. strobiformis*, 27 jun 2005. 2454 m, *D. Ramírez Noya 2664* (CIIDIR).

*Hofmeisteria schaffneri* (A. Gray) R.M. King & H. Rob.Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 27 may 2002, bosque de *Pinus teocote, P. lumholtzi y Quercus spp.*, 1520 m, *D. Ramírez Noya 2160* (CIIDIR).

*Hymenostephium cordatum* (Hook. & Arn.) S.F. Blake. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 7 nov 2001, bosque de *Pinus teocote, P. lumholtzi y Quercus* spp., 1520 m, *D. Ramírez Noya 2067* (CIIDIR).

*Iostephane heterophylla* (Cav.) Benth. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'45"N, 106°58'20"W, 21 ago 2008, Llanura en el bosque de pino, 2450 m, *D. Ramírez Noya 2968* (CIIDIR).

*Jaegueria hirta* (Lag.) Less. Sta Matilde, Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'21"N, 106°57'53"W, 24 may 2003, bosque tropical caducifolio con*Lysilomaspp.*, *Acacia spp.*, *Bursera spp.* y *Ficus spp.*, 670 m, *D. Ramírez Noya 2363* (CIIDIR). Potreritos, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'17"N, 106°58'30"W, 21 sep 2008, bosque de pino abierto, 2435 m, *D. Ramírez Noya 3020* (CIIDIR).

*Jaegueria purpurascens* Rob. El Tecuán, Tamazula, Dgo., 25°33'45"N, 106°57'30"W, 20 sep 2008, bosque de pino abierto, 2425 m, *D. Ramírez Noya 3012* (CIIDIR).

*Laenecia confusa* (Cronquist) G.L. Nesom. El Aguaje, El Durazno, Tamazula, Dgo., 25°21'36.8"N, 106°56'21.8"W. 9 oct 2014, bosque tropical caducifolio con*Lippia umbellata, Montanoa leucantha* e *Ipomoea arborescens*, 1509 m, *D. Ramírez Noya 4199* (CIIDIR).

*Laennecia gnaphalioides* (Kunth) Cass, San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'05"N, 106°57'30"W, 15 oct 2013, terreno de cultivo, 2410 m, *D. Ramírez Noya 3978 c* (CIIDIR).

*Laennecia schiedeana* (Less.) G.L.Nesom. Cerca a San Dario-Aguajes, 25°23'16"N, 106°55'58"W, 12 oct 2003, bosque de pino (*Pinus durangensis y P. strobiformis*), 2071 m, *D. Ramírez Noya2414* (CIIDIR).

*Laennecia sophiifolia* (Kunth) G.L. Nesom. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 15 oct 2003, bosque de *Pinus teocote, P. lumholtzii* y *Quercus spp.*, 1650 m, *D. Ramírez Noya 2487*(CIIDIR).

*Lagascea decipiens* Hemsl. var. *decipiens* Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'35"N, 106°56'42"W, 14 oct 2003, bosque tropical caducifolio, 1200 m, *D. Ramírez Noya 2461* (CIIDIR).

*Lasianthaea ceanothifolia* (Willd.) K.M. Becker var. *gracilis* (W.W. Jones) K.M. Becker.Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 7 nov 2001, bosque de *Pinus teocote*, *P. lumholtzi* y *Quercus spp.*, 1520 m, *D. Ramírez Noya 2064* (CIIDIR).

*Lasianthaea fruticosa* (L.) K.M. Becker var. *fasciculata* (DC.) K.M. Becker. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 13 oct 2003, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp.*, 1520 m, *D. Ramírez Noya 2438* (CIIDIR).

*Lasianthaea fruticosa* (L.) K.M. Becker var. *michoacana* (S.F. Blake) K.M. Becker. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 13 oct 2003, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp.*, 1520 m, *D. Ramírez Noya 2430* (CIIDIR).

*Lasianthaea seemannii* (A. Gray) K.M. Becker. Predio La Presa. Los Aguajes, El Durazno, Tamazula, Dgo.,25°22'01"N, 106°56'27"W, 8 nov 2001, bosque de *Quercus* spp.*, Magnolia* sp.*, Bursera* sp.*,* 1525 m, *D. Ramírez Noya 2096* (CIIDIR).

*Leibnitzia lyrata* (Sch. Bip.) G.L. Nesom. Corral de Piedra, El Tecuan, El Durazno, Tamazula, Dgo., bosque de pino abierto, 25°34'25"N, 106°58'24"W, 21 ago 2008, 2435 m, *D. Ramírez Noya 2866, 3011* (CIIDIR).

Tabla 1. (continued)

*Melampodium bibracteatum* S. Wats. Potreritos, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'17"N, 106°58'30"W,21 sep 2008, bosque de pino abierto, 2435 m, *D. Ramírez Noya 3021* (CIIDIR).

*Melampodium perfoliatum* (Cav.) Kunth. Potreritos, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'17"N, 106°58'30"W, 21 sep 2008, bosque de pino abierto, 2435 m, *D. Ramírez Noya 3049* (CIIDIR).

*Montanoa leucantha* (Lag.) S.F. Blake var. *arborescens* (DC.) B.L. Turner. Predio; La Presa. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'27"W, 8 nov 2001, bosque de *Quercus* sp., *Magnolia* sp., *Bursera* sp., 1525 m, *D. Ramírez Noya2092, 2471* (CIIDIR).

*Packera bellidifolia* (Kunth) W.A. Weber & Á. Löve San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'09"N, 106°58'33"W, bosque de *Pinus durangensis, P. strobiformis*), 10 jun 2008, 2454 m, *D. Ramírez Noya2827* (CIIDIR).

*Packera candidissima* (Greene) W.A. Weber & Á. Löve. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'09"N, 106°58'33"W, bosque de *Pinus durangensis, P. strobiformis*, 10 jun 2008, 2454 m, *D. Ramírez Noya 2826, 2865* (CIIDIR).

*Packera scalaris* (Greene) C. Jeffrey. Corral de Piedra, El Tecuan, El Durazno, Tamazula, Dgo., bosque de pino abierto, 25°34'25"N, 106°58'24"W, 21 ago 2008, 2435 m, *D. Ramírez Noya 2909* (CIIDIR). Potreritos, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'17"N, 106°58'30"W, 21 sep 2008, bosque de pino abierto, 2435 m, *D. Ramírez Noya 3038* (CIIDIR).

*Pectis prostrata* Cav. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 13 oct 2003, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp.*, 1520 m, *D. Ramírez Noya2435* (CIIDIR).

*Perityle microglossa* Benth. var. *saxosa* (Brandegee) A.M. Powell., orilla de camino, Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 9 nov 2001, bosque de *Pinusteocote, P. lumholtzi y Quercus* spp., 1520 m, *D. Ramírez Noya 2115* (CIIDIR). Arroyo Camarones, Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'40"N, 106°57'41"W, 28 may 2002, bosque tropical caducifolio con *Lysiloma spp*., *Acacia spp*., *Bursera spp*. y *Ficus spp*. 710 m, *D. Ramírez Noya 2203* (CIIDIR).

*Perymenium pringlei* B.L. Rob. & Greenm. var. *pringlei* Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'40"N, 106°56'40"W, 14 oct 2003, bosque tropical caducifolio, 1400 m, *D. Ramírez Noya 2450* (CIIDIR).

*Perymenium reticulatum* J.J. Fay. Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'40"N, 106°56'40"W, 14 oct 2003, bosque tropical caducifolio (ecotono), 1400 m, *D. Ramírez Noya 2450* (CIIDIR).

*Pinaropappus junceus* A. Gray. El Cordón, El Aguaje, El Durazno, Tamazula, Dgo., 25°21'44.5"N, 106°55'42.1"W. 9 oct 2014, bosque de *Pinus teocote, P. lumholtzi* y *Quercus* spp., 1850 m, *D. Ramírez Noya 4189* (CIIDIR).

*Pinaropappus roseus.* (Less.) Less. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'09"N, 106°58'33"W, bosque de *Pinus durangensis, P. strobiformis*, 10 jun 2008, 2454 m, *D. Ramírez Noya 2819, 2831* (CIIDIR).

*Pippenalia delphinifolia* (Rydb.) McVaugh. El Tecuán, Tamazula, Dgo., 25°33'45"N, 106°57'30"W, 20 sep 2008, bosque de pino abierto, 2425 m, *D. Ramírez Noya 3017* (CIIDIR).

*Porophyllum linaria* (Cav.) DC. Próximo a El Cordón, El Aguaje, El Durazno, Tamazula, Dgo., 25°21'50"N, 106°55'50"W, 10 oct 2014, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp*., 1790 m, *D. Ramírez Noya 4213* (CIIDIR).

*Porophyllum macrocephalum* DC., orilla de camino, Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 9 nov 2001, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp*., 1520 m, *D. Ramírez Noya 2150* (CIIDIR).

*Porophyllum pringlei* B.L. Rob.La Gentilera, Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'41"N, 106°57'08.3"W, 8 oct 2014, bosque tropical caducifolio, 1090 m, *D. Ramírez Noya 4130* (CIIDIR).

*Psacalium globosum* (B.L. Rob. & Fernald) H. Rob. & Brettell. Corral de Piedra, El Tecuan, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 16 oct 2013, pastizal inducido, 2435 m, *D. Ramírez Noya 3995* (CIIDIR).

*Psacalium sinuatum* (Cerv.) H. Rob. & Brettell. Corral de Piedra, El Tecuan, El Durazno, Tamazula, Dgo., bosque de pino abierto, 25°34'25"N, 106°58'24"W, 21 ago 2008, 2435 m, *D. Ramírez Noya 2887* (CIIDIR).

*Pseudelephantopus spicatus* (Juss. ex Aubl.) Rohr. Sta Matilde, Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'21"N, 106°57'53"W, 24 may 2003, bosque tropical caducifolio con *Lysiloma* spp., *Acacia* spp., *Bursera* spp. y *Ficus spp*., 670 m, *D. Ramírez Noya 2366, 2470* (CIIDIR).

*Pseudognaphalium oxyphyllum* (DC.) Kirb.El Aguaje, El Durazno, Tamazula, Dgo., 25°21'36.8"N, 106°56'21.8"W, 9 oct 2014, bosque tropical caducifolio con *Lippia umbellata, Montnoa leucantha* e *Ipomoea arborescens*, 1509 m, *D. Ramírez Noya 4192* (CIIDIR).

*Psedognaphalium semiamplexicaule* (DC.) Anderb. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 9 oct 2014, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp*., 1520 m, *D. Ramírez Noya 4161* (CIIDIR).

*Ratibida mexicana* (S. Watson) W.M. Sharp. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'45"N, 106°58'20"W, 21 ago 2008, Llanura en el bosque de pino, 2450 m, *D. Ramírez Noya 2847* (CIIDIR).

*Roldana chapalensis* (S. Watson) H. Rob. & Brettell. Predio La Manga, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'10"N 106°57'32", 15 oct 2013, bosque de *Pinus cooperi, P. leiophylla* y *P. teocote*, 2420 m, *D. Ramírez Noya 3979* (CIIDIR).

*Roldana hartwegii* (Benth.) H. Rob. & Brettell. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'10"N, 106°56'20"W, 15 oct 2003, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp*., 1650 m, *D. Ramírez Noya 2486* (CIIDIR).

*Schkuhria pinnata* (Lam.) Kuntze var. *wislizenii* (A. Gray) B.L. Turner. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'45"N, 106°58'20"W, 21 ago 2008, Llanura en el bosque de pino, 2450 m, *D. Ramírez Noya 2852* (CIIDIR).

*Sclerocarpus sessilifolius* Greenm. El Aguaje, El Durazno, Tamazula, Dgo., 25°21'36.8"N, 106°56'21.8"W, 9 oct 2014, bosque tropical caducifolio con *Lippia umbellata, Montnoa leucantha* e *Ipomoea arborescens*, 1509 m, *D.Ramírez Noya 4193-b* (CIIDIR).

*Senecio stoechadiformis* DC. La Aguateca El Tecuán , El Durazno, Tamazula, Dgo., 25°33'35"N, 106°59'45"W, bosque de *Pinus durangensis, P. arizonica*, 3 abr 2008, 2250 m, *D. Ramírez Noya 2794, 2797* (CIIDIR).

*Sigesbeckia jorullensis* Kunth. Potreritos, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'17"N, 106°58'30"W, 21 sep 2008, bosque de pino abierto, 2435 m, *D. Ramírez Noya 2048, 3060* (CIIDIR).

*Simsia amplexicaulis* (Cav.) Pers.Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 27 may 2002, bosque de *Pinus teocote, P. lumholtzi* y *Quercus* spp., 1520 m, *D. Ramírez Noya 2165* (CIIDIR). De amplia distribución, encontrada en casi todas las localidades.

Tabla 1. (continued)

*Sinclairia palmeri* (A. Gray) B.L. Turner. Potreritos, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'17"N, 106°58'30"W, 21 sep 2008, bosque de pino abierto, 2435 m, *D. Ramírez Noya 3034b* (CIIDIR).

*Stenocarpha filiformis* (Hemsl.) S.F. Blake. Cerca a San Darío-Aguajes, 25°23'16"N, 106°55'58"W, 12 oct 2003, bosque de *Pinus durangensis* y *P. strobiformis*, 2071 m, *D. Ramírez Noya 2417* (CIIDIR).

*Stevia aschenborniana* Sch. Bip. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 10 dic 2014, bosque de pino *Pinus teocote, P. lumholtzi* y *Quercus* spp., 1520 m, *D. Ramírez Noya 4275* (CIIDIR).

*Stevia jorullensis* Kunth. Potreritos, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'17"N, 106°58'30"W, 21 sep 2008, bosque de pino abierto, 2435 m, *D. Ramírez Noya 3063* (CIIDIR).

*Stevia micradenia* B.L. Rob. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22' 01"N, 106°56'26"W, 9 oct 2014, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp*., 1650 m, *D. Ramírez Noya 4187* (CIIDIR).

*Stevia myricoides* McVaugh.Aguazul, El Tecuán, Tamazula, Dgo., 25°33'40"N, 107°01'10"W, 3 abr 2008, bosque de *Quercus spp*., 1700 m, *D. Ramírez Noya 2802* (CIIDIR).

*Stevia origanoides* Kunth. Cerca a San Dario-Aguajes, 25°23'16"N, 106°55'58"W, 12 oct 2003, bosque de *Pinus durangensis y P. strobiformis*, 2071 m, *D. Ramírez Noya 2419* (CIIDIR).

*Stevia ovata* Willd. Predio; La Presa. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'27"W, 8 nov 2001, bosque de *Quercus* sp., *Magnolia* sp., *Bursera* sp., 1525 m, *D. Ramírez Noya 2081,3002-b* (CIIDIR).

*Stevia purpusii* B.L. Rob. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 9 oct 2014, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp*., 1650 m, *D. Ramírez Noya 4162* (CIIDIR).

*Stevia serrata* Cav. Corral de Piedra, El Tecuan, El Durazno, Tamazula, Dgo., bosque de pino abierto, 25°34'25"N, 106°58'24"W, 21 ago 2008, 2435 m, *D. Ramírez Noya 2893, 3002* (CIIDIR).

*Stevia trifida* Lag. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 22 may 2003, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp*., 1520 m, *D. Ramírez Noya 2331, 3955* (CIIDIR).

*Symphyotrichum expansum* (Poepp. ex Spreng.) G.L. Nesom, orilla de camino, Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 9 nov 2001, bosque de *Pinus teocote, P. lumholtzi* y *Quercus* spp., 1520 m, *D. Ramírez Noya 2122, 3955-b* (CIIDIR).

*Symphyotrichum potosinum* (A. Gray) G.L. Nesom. Corral de Piedra, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'05"N, 106°58'15"W, 16 oct 2013, acuática, creciendo dentro del arroyo permanente, 2435 m, *D. Ramírez Noya 4001* (CIIDIR).

*Tagetes filifolia* Lag. Corral de Piedra, El Tecuan, El Durazno, Tamazula, Dgo., bosque de pino abierto, 25°34'25"N, 106°58'24"W, 21 ago 2008, 2435 m, *D. Ramírez Noya 2862, 2891* (CIIDIR).

*Tagetes foetidissima* DC.Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 27 may 2002, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp*., 1520 m, *D. Ramírez Noya 2168* (CIIDIR).

*Tagetes micrantha* Cav. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 9 oct 2014, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp*., 1520 m, *D. Ramírez Noya 4158-b* (CIIDIR). De amplia distribución, encontrada en casi todas las localidades.

*Tagetes palmeri* A. Gray. Cerca a San Dario-Aguajes, 25°23'16"N, 106°55'58"W, 7 nov 2001, bosque de *Pinus durangensis* y *P. strobiformis*, 2071 m, *D. Ramírez Noya 2054* (CIIDIR).

*Tagetes pringlei* S. Watson. Corral de Piedra, El Tecuan, El Durazno, Tamazula, Dgo., dentro del arroyo, 25°34'25"N, 106°58'24"W, 21 ago 2008, 2435 m, *D. Ramírez Noya 2906* (CIIDIR).

*Tagetes subulata* Cerv. Cerca a San Dario-Aguajes, 25°23'16"N, 106°55'58"W, 12 oct 2003, bosque de *Pinus durangensis* y *P. strobiformis*, 2071 m, *D. Ramírez Noya 2418* (CIIDIR).

*Tithonia fruticosa* S. Canby & Rose. Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'40"N, 106°56'40"W, 30 jun 2005, bosque tropical caducifolio, 1400 m, *D. Ramírez Noya 2721* (CIIDIR).

*Tithonia tubiformis* (Jacq.) Cass. El Aguaje, El Durazno, Tamazula, Dgo., 25°21'36.8"N, 106°56'21.8"W, 9 oct 2014, bosque tropical caducifolio con *Lippia umbellata, Montanoa leucantha* e *Ipomoea arborescens*, 1509 m, *D. Ramírez Noya 4191* (CIIDIR). Especie escasa en la localidad.

*Tridax mexicana* A.M. Powell. La Presa. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'27"W, 8 nov 2001, bosque de *Quercus* spp., *Magnolia* sp., *Bursera* sp., 1525 m, *D. Ramírez Noya 2170* (CIIDIR).

*Trigonospermum annum* McVaugh & Lask. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'08"N, 106°56'52"W, 8 oct 2014, bosque de *Quercus spp*., 1481 m, *D. Ramírez Noya 4099* (CIIDIR).

*Verbesina longifolia* (A. Gray) A. Gray. Potreritos, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'17"N, 106°58'30"W, 21 sep 2008, bosque de pino abierto, 2435 m, *D. Ramírez Noya 3030* (CIIDIR).

*Verbesina oncophora* B.L.Rob & Seat. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 22 ago 2008, bosque de *Pinus durangensis, P. strobiformis, P. arizonica*, 25°34'42"N, 106°58'32"W, 2455 m, *D. Ramírez Noya 2930* (CIIDIR).

*Verbesina parviflora* (Kunth) S.F. Blake var. *parviflora*.San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'45"N, 106°58'20"W, 21 ago 2008, Llanura en el bosque de pino, 2450 m, *D. Ramírez Noya 2846, 2972* (CIIDIR).

*Vernonanthura liatroides* (DC.) H. Rob. La Aguateca El Tecuán, El Durazno, Tamazula, Dgo., 25°33'35"N, 106°59'45"W, bosque de *Pinus durangensis, P. arizonica*, 3 abr 2008, 2250 m, *D. Ramírez Noya 2790, 2801* (CIIDIR).

*Viguiera dentata* (Cav.) Spreng. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 13 oct 2003, bosque de *Pinus teocote, P. lumholtzi* y *Quercus spp*., 1520 m, *D. Ramírez Noya 2425, 3952* (CIIDIR).

*Xanthisma stenolobum* (Greene) D.R. Morgan & R.L. Hartm. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'45"N, 106°58'20"W, 21 ago 2008, Llanura en el bosque de pino, 2450 m, *D. Ramírez Noya 2966* (CIIDIR).

*Xanthocephalum benthamianum* Hemsl. San Juan, El Tecuan, El Durazno, Tamazula, Dgo., 25°34'45"N, 106°58'20"W, 21 ago 2008, Llanura en el bosque de pino, 2450 m, *D. Ramírez Noya 2967, 3951* (CIIDIR).

Tabla 1. (continued)

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*Zinnia americana* (Mill.) Olorode & A.M. Torres. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 13 oct 2003, bosque de *Pinus teocote, P. lumholtzi* y *Quercus* spp., 1520 m, *D. Ramírez Noya 2437* (CIIDIR). Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'27"N, 106°56'57"W, 14 oct 2003, bosque tropical caducifolio, 1100 m, *D. Ramírez Noya 2467* (CIIDIR).

*Zinnia angustifolia* Kunth var. *angustifolia*. Predio La Presa. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'27"W, 8 Nov 2001, bosque de *Quercus* spp., *Magnolia* sp., *Bursera* sp., 1525 m, *D. Ramírez Noya 2078* (CIIDIR).

*Zinnia angustifolia* Kunth var. *greggii* (B.L. Rob & Greenm.) McVaugh. Los Aguajes, El Durazno, Tamazula, Dgo., 25°22'01"N, 106°56'26"W, 7 Nov 2001, bosque de *Pinus teocote*, *P. lumholtzi* y *Quercus spp.*, 1520 m, *D. Ramírez Noya 2066* (CIIDIR).

*Zinnia peruviana* (L.) L. Los Aguajes, El Durazno, Tamazula, Dgo., 25°21'45"N, 106°56'30.11"W, 9 oct 2014, bosque tropical caducifolio con *Lippia umbellata, Montanoa leucantha* e *Ipomoea arborescens*, 1520 m, *D. Ramírez Noya 2147* (CIIDIR).

*Zinnia tenuis* (S. Watson) Strother. El Tecuán, Tamazula, Dgo., 25°33'45"N, 106°57'30"W, 20 sep 2008, bosque de pino abierto, 2425 m, *D. Ramírez Noya 3010*, *3016* (CIIDIR).

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## METODOLOGÍA

El presente trabajo se realizó de forma paralela, al colaborar el primer autor (D. Ramírez Noya) con otros proyectos no botánicos, llevados a cabo en el CIIDIR Durango. El propósito inicial fue realizar un registro de las especies de Asteráceas que pudieran significar ser elementos novedosos para la entidad, omitiendo la recolecta y registro de aquellas especies comunes por su amplia distribución geográfica y recolectando solo 2 a 3 ejemplares de herbario de las especies de distribución restringida. La idea de integrar un inventario de las asteráceas observadas durante los recorridos, surgió posteriormente, razón por la cual las recolectas de ejemplares no fueron planeadas para ser abundantes y se reconocen las carencias del inventario realizado, sin que por ello se quiera dejar de reportar los hallazgos registrados.

Los ejemplares recolectados se depositaron en el Herbario CIIDIR, donde fueron identificados críticamente, utilizando floras, monografías y revisiones (Bremer y Humphries 1993; King & Robinson 1987; McVaugh 1984; Nesom 1989 a y b, 1992; Sorensen 1969, Strother 1969, 1986; Torres 1964; Turner 1985 a y b, 1996, 1997, entre otros más). Los ejemplares identificados se cotejaron con las descripciones que proporcionó la bibliografía consultada y posteriormente se compararon con especímenes del herbario (CIIDIR), así como llevando a cabo la consulta de imágenes disponibles en las páginas web:http://www.tropicos.org/; http://www.ipni.org/ipni/plantnamesearchpage.do; http://www.rad.unam.mx/index.php/search/; http://swbiodiversity.org/seinet/checklists/; http://www.madrean.org/symbflora/taxa/index. Personal del herbario CIIDIR distribuirá los duplicados a otros herbarios, una vez terminado el proceso de herborización del material. Es importante mencionar que antes de las recolectas del presente estudio, muchas de las especies que se citan para la Sierra Madre en Durango y que se incluyen en el presente reporte, no contaban con ejemplares de respaldo en la colección del herbario CIIDIR.

## RESULTADOS Y DISCUSIÓN

Se encontraron y se reportan aquí 75 géneros y 149 especies de la familia Asteraceae en las localidades muestreadas de la región de El Durazno y cercanías, Tamazula, Durango (Tabla 1), 17 de estas especies y una variedad (*Lagascea decipiens* var. *decipiens*) son nuevos registros para Durango (Tabla 2). En la Tabla 3 se señala la distribución de las especies encontradas en los diferentes tipos de vegetación de la región muestreada, las especies sinantrópicas (Villaseñor 2012), la distribución geográfica general de los taxa encontrados, asi como las especies de distribución geográfica restringida a México (Rzedowski 1991a). En un intento de jerarquizar la magnitud del endemismo en México se consideran aquí dos niveles: a) especies presentes en más de 5 estados de la república, son endémicas de México, y b) especies presentes en uno a cuatro estados de la Republica Mexicana, son endemismos regionales.

De los nuevos registros es interesante observar que especies conocidas de una sola localidad en: Michoacán, *Baccharis multiflora* var. *herbacea*, Sinaloa, *Coreocarpus congregatus* y Estado de México, *Perymenium reticulatum* son ahora registradas en Durango, lo que amplia su área de distribución conocida a una región muy alejada, mientras que especies como *Coreocarpus arizonicus* var. *filiformis* y *Pinaropappus junceus*, que eran

Tabla 2. Nuevos registros para el estado de Durango, México

| **Especies** | **Distribución conocida** |
|---|---|
| *Ageratum corymbosum* Zucc. f. *euryphyllum* (B.L. Rob.) M.F. Johnson | Ags., Gto., Hgo., Jal., Mor., Qro., S.L.P., Zac. |
| *Baccharis multiflora* Kunth var. *herbacea* McVaugh | Mich. |
| *Brickellia filipes* B.L. Rob. | Col., Gro., Jal., Mich., Oax. |
| *Chromolaena odorata* (L.) R.M. King & H. Rob. | América tropical; África; Viet Nam; c-s de Méx. |
| *Coreocarpus arizonicus* (A. Gray) S.F. Blake var. *filiformis* (Greenm.) S.F. Blake | Chi., Sin., Son. |
| *Coreocarpus congregatus* (S.F. Blake) E.B. Sm. | Sin. |
| *Gamochaeta americana* (Mill.) Wedd. | Am trop.; Chis., D.F., Gro., Hgo., Jal., Méx., Mich., Oax., Pue., Sin., Ver., Zac. |
| *Hymenostephium cordatum* (Hook. & Arn.) S.F. Blake | Chis., Hgo., Mex., N.L., S.L.P., Sin., Ver.; CAm |
| *Lagascea decipiens* Hemsl. var. *decipiens* | S Arizona, Chih., Gro., Mich., Sin., Son., Oax. |
| *Lasianthaea fruticosa* (L.) K.M. Becker var. *michoacana* (DC.) K.M. Becker | Gro., Jal., Méx., Mich., Mor. |
| *Perymenium reticulatum* J.J. Fay | Méx. |
| *Pinaropappus junceus* A. Gray | Chih., Sin., Son. |
| *Porophyllum pringlei* B.L. Rob. | Chis., Gro., Jal., Mex., Mich., Mor., Oax., Sin. |
| *Pseudognaphalium oxyphyllum* (DC.) Kirp. | Ags., D.F.,Gto., Hgo., Jal., Mor., Pue., Qro., Ver., Zac. |
| *Pseudognaphalium semiamplexicaule* (DC.) Anderb. | Chis., Mich., Pue., Tams.; CAm |
| *Roldana chapalensis* (S. Watson) H. Rob. & Brettell. | Ags., Col., Gto., Gro., Jal., Mex., Mich., Mor., Oax., Sin., Zac. |
| *Stevia aschenborniana* Sch. Bip. | Chih., Gro., Jal., Mich., Nay., Sin. |
| *Stevia purpusii* B.L. Rob. | Ags., D.F., Gto., Gro., Hgo., Mex., Mich., Mor., Oax., Pue., Qro. |

*Regiones*: Am= América, CAm= Centroamérica, NAm= Norteamérica, SAm= Sudamérica. *País*: Méx= México. *Estados*: Chis= Chiapas, Ch= Chihuahua, Co= Coahuila, D= Durango, G= Guerrero, J= Jalisco, Mi= Michoacán, N= Nayarit, O= Oaxaca, SLP= San Luis Potosí, Si= Sinaloa, So= Sonora. Ac= Acuática.

conocidas de Estados colindantes con Durango (Chihuahua, Sinaloa y Sonora), se registran ahora en el estado. Las otras 12 especies incluidas en la Tabla 2 se distribuyen en regiones conformadas por más de 5 Estados y en muchas de ellas bastante alejados de nuestra región de estudio, lo que representa su registro una importante ampiación de su área de distribución conocida.

Otras especies interesantes de mencionar son aquellas cuya distribución conocida es muy cercana a la región de nuestro estudio; por ejemplo *Lagasca decipiens* var. *glandulosa* es reportada de Sonora y Sinaloa (Stuessy 1978), recolectada también por D. Ramírez N. de Durango (en San Juan de Camarones, Santiago Papasquiaro, a 24°55'37"N, 106°24'49"W, 604 m de altitud); mientras que *Lagasca decipiens* var. *decipiens* reportada del sur de Arizona, Sonora, Chihuahua, Sinaloa, Michoacán, Guerrero y Oaxaca (McVaugh 1984), es considerada un caso inusual de distribución bicéntrica, por la carencia de ejemplares provenientes de Nayarit y Durango. Aquí la reportamos por primera vez de Durango, creciendo en Los Aguajes, El Durazno, Tamazula, Dgo., a 25°21'35" 106°56'42", 1200 m de altitud. La diferencia que presentan los ejemplares no dejan lugar a dudas de su identificación, ya que *Lagascea decipiens* var. *decipiens* presenta pedúnculos pilosos y no posee las glándulas estipitadas que si presenta la variedad *glandulosa* (McVaugh 1984). Esto no concuerda con el posible bicentrismo propuesto por McVaugh, ampliandose la distribución geográfica conocida de esta variedad. Otro dato a observar es la diferencia de altitudes en las que se distribuyen las dos variedades: la variedad glandulosa a unos 604 m y la variedad típica por encima de los 1200 m.

Las preferencias de hábitat señalan que el mayor número de especies de Asteráceas en esta región se distribuyen en el Bosque de Coníferas (49.34%), en altitudes de 2050 a 2550 m. Le siguen en importancia las que habitan en el Bosque de Pino- Encino (39.47%), en altitudes de 1500 a 1900 m y el menor número se encuentra en el Bosque Tropical Caducifolio (22.37%), en altitudes de 670 a 1000 m. Resultados similares son reportados por Suárez y Villaseñor (2011) para el Estado de Oaxaca, quienes observaron que la riqueza de especies de asteráceas es mucho mayor en los bosques templados que en los bosques tropicales húmedos de Oaxaca. Aun cuando los ecosistemas de Durango son más secos (bosques templados sub-húmedos y bosque tropical

Tabla 3. Listado florístico de las Asteráceas en la región del Durazno y cercanías, Tamazula, Durango, México. Bosque de Coníferas= B Coníferas, Bosque de *Quercus-Pinus* = BQ-P, Bosque Tropical Caducifolio = BTC.

| ESPECIES | B Coniferas | B Q P | B T C | Sinantrópica | Distribución Americana | Endémicas de: | Distribución más amplia |
|---|---|---|---|---|---|---|---|
| *Acmella radicans* (Jacq.) R.K. Jansen | | X | X | X | SAm | | |
| *Acmella repens* (Walter) Rich. | | | X | | SAm | | |
| *Acourtia macrocephala* Sch. Bip. | X | | | | NAm | | |
| *Adenophyllum anomalum* (Canby & Rose) Strother | | | X | | | Méx | |
| *Adenophyllum cancellatum* (Cass.) Villarreal | | X | | X | | D,Si | |
| *Adenophyllum porophyllum* (Cav.) Hemsl. | | | X | | CAm | | |
| *Ageratina hederifolia* (A. Gray) R.M. King & H. Rob. | X | | | | | D,SLP,Ch | |
| *Ageratina choricephala* (B.L. Rob.) R.M. King & H. Rob. | | X | | | | Méx | |
| *Ageratina malacolepis* (B.L. Rob.) R.M. King & H. Rob. | | | X | | | Méx | |
| *Ageratina palmeri* (A. Gray) Gage ex B.L. Turner | | X | | | | Méx | |
| *Ageratina pazcuarensis* (Kunth) R.M. King & H. Rob. | X | | | | CAm | | |
| *Ageratum corymbosum* Zucc. f. corymbosum | X | | | | CAm | | |
| *Ageratum corymbosum* f. *euryphyllum* (B.L. Rob.) M.F. Johnson | | X | | | | Méx | |
| *Alloispermum palmeri* (A. Gray) C.F. Fernández & Urbatsch | | X | | | | D,J | |
| *Ambrosia ambrosioides* (Cav.) W.W. Payne | | | X | X | Nam | | |
| *Artemisia ludoviciana* Nutt. | X | | | X | NAm | | |
| *Baccharis multiflora var. herbacea* McVaugh | X | | | | | Mi | |
| *Baccharis pteronioides* DC. | X | X | X | X | NAm | | |
| *Baccharis salicifolia* (Ruiz & Pav.) Pers. | X | | | | SAm | | |
| *Barkleyanthus salicifolius* (Kunth) H. Rob. & Brettell | X | | | X | NAm | | |
| *Bidens aurea* (Aiton) Sherff | X | | | | NAm | | |
| *Bidens bigelovii* A. Gray | | | X | | NAm | | |
| *Bidens lemmonii A.* Gray | X | | | | NAm | | |
| *Bidens ostruthioides* (DC.) Sch. Bip. | X | | | | | D | |
| *Bidens pilosa* L. | | X | | X | | | X |
| *Bidens riparia* Kunth (Semiacuática) | | | X | | SAm | | |
| *Bidens tenuisecta* A. Gray | X | | | | NAm | | |
| *Brickellia diffusa* (Vahl) A. Gray | | X | | | SAm | | |
| *Brickellia filipes* B.L. Rob. | | X | | | | Méx | |
| *Brickellia oliganthes* (Less.) A. Gray | | | X | | CAm | | |
| *Brickellia oreithales* (B.L. Rob.) Shinners | X | | | | | Méx | |
| *Brickellia secundiflora* (Lag.) A. Gray | | X | | | | Méx | |
| *Brickellia subuligera* (S. Schauer) B.L. Turner | | | X | | | Méx | |
| *Carminatia tenuiflora* DC. | | X | | | NAm | | |
| *Centaurea rothrockii* Greenm. | X | | | X | NAm | | |
| *Chaptalia runcinata* Kunth | X | | | | SAm | | |
| *Chloracantha spinosa* var. *jaliscensis* (McVaugh) S.D. Sundb. | | | X | X | | Méx | |
| *Chromolaena collina* (DC.) R.M. King & H. Rob. | | X | | | NAm | | |
| *Chromolaena odorata* (L.) R.M. King & H. Rob. | | | X | | | | X |
| *Chromolaena ovaliflora* (Hook. & Arn.) R.M. King & H. Rob. | | X | | | | Méx | |
| *Cirsium ehrenbergii* Sch. Bip. | X | | | X | | Méx | |
| *Conyza microcephala* Hemsl. | X | | | | CAm | | |
| *Coreocarpus arizonicus* (A. Gray) S.F. Blake var. *filiformis* (Greenm.) S.F. Blake | | X | | | NAm | | |
| *Coreocarpus congregatus* (S.F. Blake) E.B. Sm. | | X | | | | Si | |
| *Cosmos bipinnatus* Cav. | X | | | X | | | X |
| *Cosmos palmeri* B.L. Rob. | X | | | | | Ch,D | |
| *Cosmos parviflorus* (Jacq.) Pers. | X | | | X | NAm | | |
| *Cosmos sulphureus* Cav. | | X | | X | Am | | |
| *Critonia hebebotrya* DC. | | X | | | CAm | | |
| *Critonia quadrangularis* (DC.) R.M. King & H. Rob. | X | | | | CAm | | |
| *Critoniopsis triflosculosa* (Kunth) H. Rob. | | | X | | CAm | | |
| *Dahlia coccinea* Cav. | | X | | | SAm | | |
| *Dahlia sherffii* P.D. Sorensen | X | | | | | Ch,D,Z | |

Tabla 3. (continued)

| ESPECIES | B Coniferas | B Q P | B T C | Sinantrópica | Distribución Americana | Endémicas de: | Distribución más amplia |
|---|---|---|---|---|---|---|---|
| *Decachaeta ovatifolia* (DC.) R.M. King & H. Rob. |  | X |  |  |  | Méx |  |
| *Decachaeta scabrella* (B.L. Rob.) R.M. King & H. Rob. |  | X |  |  |  | Méx |  |
| *Delilia biflora* (L.) Kuntze |  |  | X |  | SAm |  |  |
| *Erigeron astranthoides* De Jong & Nesom | X |  |  |  |  | D |  |
| *Erigeron coroniglandifer* G.L. Nesom | X |  |  |  |  | Ch,D |  |
| *Erigeron griseus* (Greenm.) Nesom | X |  |  |  |  | D,N |  |
| *Erigeron podophyllus G.L. Nesom* | X |  |  |  |  | Ch,D |  |
| *Erigeron polycephalus* (Larsen) G.L. Nesom | X | X | X | X |  | D,J,Chis |  |
| *Erigeron seemannii* (Sch. Bip.) Greene | X |  |  |  |  | D,Ch |  |
| *Erigeron velutipes* Hook. & Arn. | X | X | X | X | NAm |  |  |
| *Erigeron wislizeni* (A. Gray) Greene | X |  |  |  |  | Ch,D |  |
| *Fleischmannia sonorae* (A. Gray) R.M. King & H. Rob. |  | X |  |  | CAm |  |  |
| *Galinsoga parviflora* Cav. |  | X |  | X |  |  | X |
| *Galinsoga quadriradiata* Ruíz & Pav. | X |  |  |  |  |  | X |
| *Gamochaeta americana* (Mill.) Wedd. | X |  |  | X | Am |  |  |
| *Guardiola rosei* B.L. Rob. |  | X |  |  |  | Ch,D,N |  |
| *Heterosperma pinnatum* Cav. | X | X | X | X | Am |  |  |
| *Heterotheca chihuahuana* B.L. Turner | X |  |  | X |  | Ch,D |  |
| *Hieracium fendleri* Sch. Bip. | X |  |  |  | NAm |  |  |
| *Hieracium schultzii* Fr. | X |  |  |  | NAm |  |  |
| *Hofmeisteria schaffneri* (A. Gray) R.M. King & H. Rob. |  | X |  |  |  | Méx |  |
| *Hymenostephium cordatum* (Hook. & Arn.) S.F. Blake |  | X |  |  | CAm |  |  |
| *Iostephane heterophylla* (Cav.) Benth. | X |  |  | X |  | Méx |  |
| *Jaegueria hirta* (Lag.) Less. (Acuática) | X |  | X |  | SAm |  |  |
| *Jaegueria purpurascens* B.L. Rob. | X |  |  |  |  | Méx |  |
| *Laennecia confusa* (Cronquist) G.L. Nesom |  |  | X |  | CAm |  |  |
| *Laennecia gnaphalioides* (Kunth) Cass | X |  |  | X | SAm |  |  |
| *Laennecia schiedeana* (Less.) G.L. Nesom | X |  |  |  | NAm |  |  |
| *Laennecia sophiifolia* (Kunth) G.L. Nesom |  | X |  | X | SAm |  |  |
| *Lagascea decipiens* Hemsl. var. *decipiens* |  |  | X |  | NAm |  |  |
| *Lasianthaea ceanothifolia* (Willd.) K.M. Becker var. *gracilis* (W.W. Jones) K.M. Becker |  | X |  |  |  | Méx |  |
| *Lasianthaea fruticosa* (L.) K.M. Becker var. *fasciculata* (DC.) K.M. Becker |  | X |  |  | CAm |  |  |
| *Lasianthaea fruticosa* (L.) K.M. Becker var. *michoacana* (S.F. Blake) K.M. Becker |  | X |  |  |  | G,Mi |  |
| *Lasianthaea seemannii* (A. Gray) K.M. Becker |  | X |  |  |  | So,D,N |  |
| *Leibnitzia lyrata* (Sch. Bip.) G.L. Nesom | X |  |  |  | CAm |  |  |
| *Melampodium bibracteatum* S. Watson | X |  |  | X | CAm |  |  |
| *Melampodium perfoliatum* (Cav.) Kunth | X |  |  | X | NAm |  |  |
| *Montanoa leucantha* var. *arborescens* (DC.) B.L. Turner |  | X |  | X |  | Méx |  |
| *Packera bellidifolia* (Kunth) W.A. Weber & A. Löve | X |  |  |  |  | Méx |  |
| *Packera candidissima* (Greene) W.A. Weber & A. Löve | X |  |  | X |  | Ch,D |  |
| *Packera scalaris* (Greene) C. Jeffrey | X |  |  |  |  | Ch,D,Co |  |
| *Pectis prostrata* Cav. |  | X |  | X | Am |  |  |
| *Perityle microglossa* var. *saxosa* (Brandegee) A.M. Powell |  | X | X | X |  | So,D,N |  |
| *Perymenium pringlei* B.L. Rob. & Greenm. var. *pringlei* |  |  | X |  |  | D,J |  |
| *Perymenium reticulatum* J.J. Fay |  |  | X |  |  | Méx |  |
| *Pinaropappus junceus* A. Gray (Nvo. Reg.) |  | X |  |  |  | Ch,Si, So |  |
| *Pinaropappus roseus.* (Less.) Less. | X |  |  | X | NAm |  |  |
| *Pippenalia delphinifolia* (Rydb.) McVaugh | X |  |  |  |  | Ch,D,Z |  |
| *Porophyllum linaria* (Cav.) DC. |  | X |  |  |  | Méx |  |
| *Porophyllum macrocephalum* DC. |  | X |  | X | NAm |  |  |
| *Porophyllum pringlei* B.L. Rob. |  |  | X |  |  | Méx |  |
| *Psacalium globosum* (B.L. Rob. & Fernald) H. Rob. & Brettell | X |  |  |  |  | Ch,D |  |
| *Psacalium sinuatum* (Cerv.) H. Rob. & Brettell | X |  |  |  |  | D,J,N,Mi |  |
| *Pseudelephantopus spicatus* (Juss. ex Aubl.) Rohr. |  |  | X |  | SAm |  |  |

Tabla 3. (continued)

| ESPECIES | B Coniferas | B Q P | B T C | Sinantrópica | Distribución Americana | Endémicas de: | Distribución más amplia |
|---|---|---|---|---|---|---|---|
| *Pseudognaphalium oxyphyllum* (DC.) Kirp. | | | X | | | Méx | |
| *Psedognaphalium semiamplexicaule* (DC.) Anderb. | | X | | | CAm | | |
| *Ratibida mexicana* (S. Watson) W.M. Sharp | X | | | | | Méx | |
| *Roldana chapalensis* (S. Watson) H. Rob. & Brettell. | | X | | | | Méx | |
| *Roldana hartwegii* (Benth.) H. Rob. & Brettell | | X | | | | Méx | |
| *Schkuhria pinnata* var. *wislizenii* (A. Gray) B.L. Turner | X | | | X | CAm | | |
| *Sclerocarpus sessilifolius* Greenm. | | | X | | | D,J,N,Si | |
| *Senecio stoechadiformis* DC. | X | | | | | Méx | |
| *Sigesbeckia jorullensis* Kunth | X | | | X | SAm | | |
| *Simsia amplexicaulis* (Cav.) Pers. | X | X | X | X | CAm | | |
| *Sinclairia palmeri* (A. Gray) B.L. Turner | X | | | | | D,N,J,Z | |
| *Stenocarpha filiformis* (Hemsl.) S.F. Blake | X | | | | | D,Si | |
| *Stevia aschenborniana* Sch. Bip. | | X | | | | Méx | |
| *Stevia jorullensis* Kunth | X | | | | CAm | | |
| *Stevia micradenia* B.L. Rob. | | X | | | | Méx | |
| *Stevia myricoides* McVaugh | | X | | | | Méx | |
| *Stevia origanoides* Kunth | X | | | | | Méx | |
| *Stevia ovata* Willd. | | X | | | Am | | |
| *Stevia purpusii* B.L. Rob. | | X | | | | Méx | |
| *Stevia serrata* Cav. | X | | | | SAm | | |
| *Stevia trifida* Lag. | | X | | | | Méx | |
| *Symphyotrichum expansum* (Poepp. ex Spreng.) G.L. Nesom | | X | | X | | | X |
| *Symphyotrichum potosinum* (A. Gray) G.L. Nesom (Acuática) | X | | | | | Méx | |
| *Tagetes filifolia* Lag. | X | | | X | SAm | | |
| *Tagetes foetidissima* DC. | | X | | | CAm | | |
| *Tagetes micrantha* Cav. | X | X | X | X | Nam | | |
| *Tagetes palmeri* A. Gray | X | | | | | Méx | |
| *Tagetes pringlei* S. Watson | X | | | | | Méx | |
| *Tagetes subulata* Cerv. | X | | | | SAm | | |
| *Tithonia fruticosa* S. Canby & Rose | | | X | | | Méx | |
| *Tithonia tubiformis* (Jacq.) Cass. | X | X | X | X | SAm | | |
| *Tridax mexicana* A.M. Powell | | X | | | CAm | | |
| *Trigonospermum annum* McVaugh & Lask. | | X | | | CAm | | |
| *Verbesina longifolia* (A. Gray) A. Gray | X | | | | NAm | | |
| *Verbesina oncophora* B.L. Rob & Seaton | X | | | | | Méx | |
| *Verbesina parviflora* (Kunth) S.F. Blake var. *parviflora* | X | | | | | Méx | |
| *Vernonanthura liatroides* (DC.) H. Rob. | X | | | | | D,O | |
| *Viguiera dentata* (Cav.) Spreng. | | X | | X | NAm | | |
| *Xanthisma stenolobum* (Greene) D.R. Morgan & R.L. Hartm. | X | | | | | D,Ch | |
| *Xanthocephalum benthamianum* Hemsl. | X | | | X | | Méx | |
| *Zinnia americana* (Mill.) Olorode & A.M. Torres | | X | X | X | CAm | | |
| *Zinnia angustifolia* Kunth. var. *angustifolia* | | X | | | CAm | | |
| *Zinnia angustifolia* var. *greggii* (B.L. Rob. & Greenm.) McVaugh | | X | | | | D,N | |
| *Zinnia peruviana* (L.) L. | | | X | X | | | X |
| *Zinnia tenuis* (S. Watson) Strother | X | | | | | D,Ch | |

*Regiones*: Am= América, CAm= Centroamérica, NAm= Norteamérica, SAm= Sudamérica. *País*: Méx= México. *Estados*: Chis= Chiapas, Ch= Chihuahua, Co= Coahuila, D= Durango, G= Guerrero, J= Jalisco, Mi= Michoacán, N= Nayarit, O= Oaxaca, SLP= San Luis Potosí, Si= Sinaloa, So= Sonora. Ac= Acuática.

caducifolio), la riqueza de especies en el ecosistema templado es marcadamente mayor que en el ecosistema tropical. Solamente se registran 2 especies de hábito acuático: *Jaegueria hirta* y *Symphyotricum potosinum*.

Un caso interesante es el comportamiento de *Tithonia tubiformis*, una maleza ampliamente distribuida en otras regiones de México. En la zona de estudio solo se registraron unos cuantos ejemplares en el área de estudio (localidad anotada en Tabla 1), lo que sugiere un buen nivel de conservación de la vegetación (¿?).

Las observaciones de la flora de Compuestas resultaron ser muy interesantes a lo largo de los recorridos realizados (Tabla 3), los que aun siendo de pequeñas dimensiones, registraron números altos de especies de esta familia. De los 149 géneros y 602 especies estimados para Durango (Balleza y Villaseñor 2002), 50.3% de los primeros y 24.7% de las segundas se encontraron en esta reducida región. Setenta y ocho especies de las 149 encontradas (52.3%) restringen su distribución a México, un aspecto sumamente interesante, ya que una de cada dos compuestas de nuestra región de estudio, son endemismos a nivel nacional. Dicho porcentaje resulta ser comparable con el 55.85% de endemismos estimado para el estado de Durango (Villaseñor et al. 2004). Los resultados señalan también que 41 especies (27.7%) son arvenses y/o ruderales (especies sinantrópicas), las cuales caracteriza a las Compuestas (Villaseñor 2012) como la segunda familia (después de las Poáceas) con una proporción alta de especies arvenses y/o ruderales.

Dos de las 148 especies encontradas presentan distribución restringida al estado de Durango, dando un valor de 1.35% de endemismo estatal. Dicha cifra resulta ser del doble que la de Zacatecas, que presenta un 0.8% de endemismo estatal, mientras que representa una décima parte del 11.3% de endemismo estimado para la flora del estado de Durango (Villaseñor 1993). Al analizar el endemismo a nivel regional (Durango, junto con uno a tres estados colindantes), se observa que 20 especies (Tabla 3) son endémicas en la región compartida de Durango con un estado colindante, otras ocho especies se conocen de Durango y dos estados colindantes y cuatro especies de Durango con tres estados colindantes. Lo anterior resulta en un total de 32 especies endémicas a nivel regional, elevando así el 1.35% de las especies endémicas a nivel estatal a un 22.97% de endemismo en la región del noroeste-norte de México. Los resultados ponen de manifiesto la importancia del alto endemismo en la zona de estudio.

Es relevante la riqueza florística de Asteráceas encontrada en una región tan pequeña como la del presente estudio, resultado que se esperaba considerando sus características fisiográficas, lo abrupto del terreno y la localización de estas quebradas en la Sierra Madre Occidental, región considerada por la CONABIO como área de exclusión. Así, podemos anotar que nuestros resultados no son comparables con los de estudios florísticos en regiones colindantes, teniendo en cuenta la falta de caminos y lo intransitable del área explorada en un intervalo altitudinal de 670–2550 m, que se dice fácil, pero que requiere de largas caminatas con el apoyo de animales de carga.

Otros resultados interesantes son las diferencias en el númerode especies con las reportadas en regiones colindantes. Por ejemplo, Nesom (1989a) en sus estudios del género *Erigeron* sección *Polyactis*, reconoce 19 especies, citando 6 de ellas para el NW de Durango, de las que cuatro especies se registran en este estudio: *Erigeron coroniglandifer*, *E. polycephalus*, *E. seemannii* y *E. astrahntioides*. Existen registros de varias especies de Asteraceae que han sido descritas de regiones adyacentes a nuestra área de estudio, como son las nuevas especies del cerro Mohinora, ubicado en el colindante municipio de Guadalupe y Calvo, Chihuahua: *Erigeron caulinifolius*, *E. circulis* (Nesom 1989a), *E. mohinorensis* (Nesom 1989b), *E. mcdonaldii* (Nesom 1990), *E. oreophilus* forma *latilobus* (Greenman 1905) y *Senecio mohinorensis* (Greenman 1907). Sin embargo, estas 6 especies encontradas en un área radial aproximada de 60 km en línea recta de la región de estudio, a pesar de su cercanía y similitud de condiciones ambientales, no fueron registradas y no se reportan en este trabajo. Una posible explicación es el microhábitat específico en el que fueron encontradas, causado principalmente por las diferencias de altitud en un terreno escarpado, provenientes de altitudes cercanas a los 3000 m, versus las recolectadas para este estudio en altitudes ostensiblemente mas bajas (690–2550 m). En un estudio reciente, McDonald et al. (2011) reportan para la parte alta del cerro Mohinora un total de 14 especies de Compuestas, de las cuales solo 2 son compartidas con la región estudiada: *Packera scalaris* y *Verbesina longifolia*. Los resultados sugieren discrepancias en su riqueza florística, aun en distancias relativamente cortas (alta diversidad beta). Por otra parte, 3 especies que fueron descritas de los vecinos muncipios de Canelas y Santiago Papasquiaro, Durango, a una altitud de 2200 m: *Galinsoga spellenbergii* (Turner 1986), *Laennecia spellenbergii* (Nesom 1992) y *Verbesina hygrophila* (Panero y Villaseñor 1993), y una adicional, *Verbesina torresii* (Turner 1985b) de la localidad El Catorce, municipio Tepehuanes, Durango, a solo 35 km de El Durazno y 1400 m de altitud, no se encontraron durante los recorridos de campo, aun cuando las altitudes de donde fueron descritas también se encuentran dentro del intervalo altitudinal muestreado, a una distancia lineal menor a 50 km en línea recta. Nuevamente estos resultados sugieren que en la Sierra Madre Occidental lo abrupto del terreno confiere una alta riqueza florística en diferencias de coordenadas geográficas cortas, lo que provee microhábitats diversos que permiten el desarrollo de endemismos y una alta diversidad beta.

El estudio de Vega Aviña et al. (2000), reporta las especies endémicas para la región oeste y noroeste de México. De ellas, 26 especies en 23 géneros son Asteráceas, presentes en el municipio de Culiacán, Sinaloa, colindante con el municipio de Tamazula y del cual solamente una pequeña porción al noreste son terrenos colindantes con nuestra área de estudio. De las 26 especies reportadas solamente se encontraron en la zona estudiada *Adenophyllum anomalum, Lasianthaea ceanothifolia* var. *gracilis, Lasianthaea seemannii* y *Perityle microglossa* var. *saxosa*. La explicación al bajo número de especies compartidas seguramente es que Vega Aviña y colaboradores exploraron y recolectaron principalmente en la planicie costera del municipio de Culiacán, en altitudes de 0 a 300 m la mayoría (rara vez por areriba de los 500 m), al parecer excluyendo localidades en las serranías del municipio (760 a 860 m), mismas que representan la subida a la Sierra Madre Occidental, en el área colindante con nuestra área de estudio por encima de 1500 m de altitud.

Los resultados del presente estudiorevelan una alta riqueza de endemismos de la familia Asteraceae en esta franja de la Sierra Madre Occidental, cadena montañosa donde las pendientes pronunciadas del terreno unido a los conflictos sociales que le caracterizan, desmotivan la exploración biológica necesaria para estudios florísticos. Se infiere que existen otras porciones de la región de las quebradas de la Sierra Madre Occidental que se encuentran todavía subexploradas y que seguramente integran un territorio de alta diversidad biológica y riqueza de endemismos, lo que podrá corroborarse con muestreos sistemáticos en estudios futuros.

En la Tabla 3 se indica la distribución geográfica de las especies registradas. Destacan las especies con afinidad Neartica (26), distribuidas de México a Norteamerica, mientras que 23 de ellas son de afinidad Neotropical, restringidas principalmente a la region mesoamericanas (Davidse et al. 1994). Solamente 17 especies se distribuyen más al sur, hasta Sudamérica. Finalmente resulta interesante que 96% de los géneros y 95.3% de las especies se distribuyen solo en América y el porcentaje restante de especies son ahora de distribución más amplia, ya que aparentemente han logrado establecerse como malezas en localidades del Viejo Mundo (Tabla 3).

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# REDESCUBRIMIENTO DE *DESMODIUM ANGUSTIFOLIUM* (FABACEAE) EN EL SALVADOR

Pablo Galán

*Herbario LAGU, Jardín Botánico La Laguna*
*Urbanización Industrial Plan de La Laguna, Antiguo Cuscatlán*
*Apdo. Postal 1197 CG, La Libertad, EL SALVADOR*
*pgogalan@gmail.com*

## RESUMEN

Se recolecta nuevamente *Desmodium angustifolium* para El Salvador, después de 43 años de no tener registros de ésta especie en el país. Es un arbusto débil que se distingue fácilmente de otros *Desmodium* por sus hojas muy angostas y largas. Se encontró en 3 departamentos: 2 al occidente y uno en la zona oriental del país.

## ABSTRACT

*Desmodium angustifolium* is collected again in El Salvador, after 43 years of not having records of the species in the country. It is a weak shrub that is easily distinguished from other *Desmodium* species by very narrow and long leaves. It was found in three states: two in the west and the other in the east of the country.

Key Words: *Desmodium, Hedysarum,* Fabaceae, Morazán, Sonsonate, Santa Ana, El Salvador

## INTRODUCCIÓN

En El Salvador, la familia Leguminosae (Fabaceae); conformada por sus tres subfamilias, es una de las más numerosas. Para el género *Desmodium* Desv. subfamilia Papilionoideae, se reportan 21 especies; ubicadas en los herbarios LAGU y MHES.

El primer registro de *D. angustifolium*; es la colectada por Otto Rohweder, el 13 de Agosto de 1950 en la Hacienda San José de la Finca Montecristo en Metapán, Santa Ana; zona noroccidental de El Salvador a una altitud entre 850 a1000 m.s.n.m. y depositada en el herbario del Missouri Botanical Garden (MO) (Tropicos.org).

## DESCRIPCION DEL GENERO

***Desmodium*** Desv.

Plantas herbáceas a sufrutescentes, postradas, erectas o trepadoras. Folíolos 1–3, mucronados, estipelas presentes; estípulas generalmente libres o connadas, la mayoría oblicuamente ovadas, largamente atenuadas, estriadas, puberulentas en la superficie dorsal, ciliadas. Inflorescencias racemosas o paniculadas, axilares y terminales, brácteas estriadas, ciliadas; cáliz bilobado, lobo superior bífido, lobo inferior 3-dentado; pétalos púrpuras, azules, rojos o blancos (raramente verdosos o amarillentos), estandarte orbicular a obovado, unguiculado, alas falcadas, auriculadas, unguiculadas, carina fusionada; estambres 10, diadelfos, el vexilar fusionado con el tubo ca 1/3 de su longitud, tubo estaminal persistente en la base del fruto maduro. Lomentos de forma variada, 1–9 articulados, planos, enrollados, incurvados, recurvados o incurvado-recurvados, plegados, principalmente indehiscentes, sésiles o estipitados (Stevens et al. 2001).

## DESCRIPCION DE LA ESPECIE

**Desmodium angustifolium** Kunth (*Hedysarum angustifolium* Kunth) es una hierba escandente o arbusto débil de hasta 2 m; tallo y corteza leñosa, marrón a rojiza; hojas con un folíolo lineal, angostos; flores papilionoideas, rosadas; los frutos son lomentos de hasta 3 mm de largo y 1–3 mm de ancho (Figs. 1, 2).

*Distribución y hábitat*.—México al norte de Sudamérica, de 700 a 1400 m.s.n.m. (Stevens et al. 2001).

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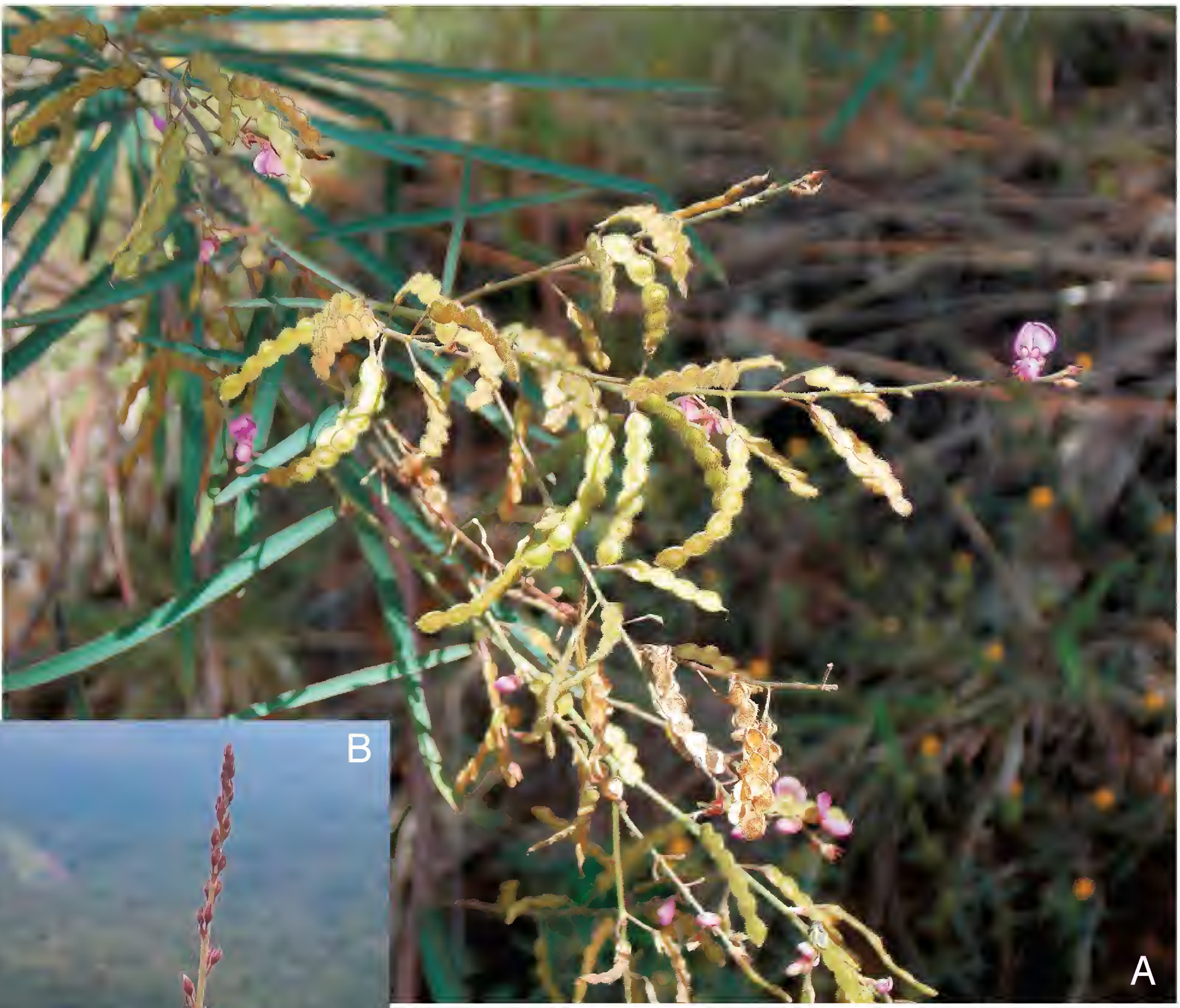

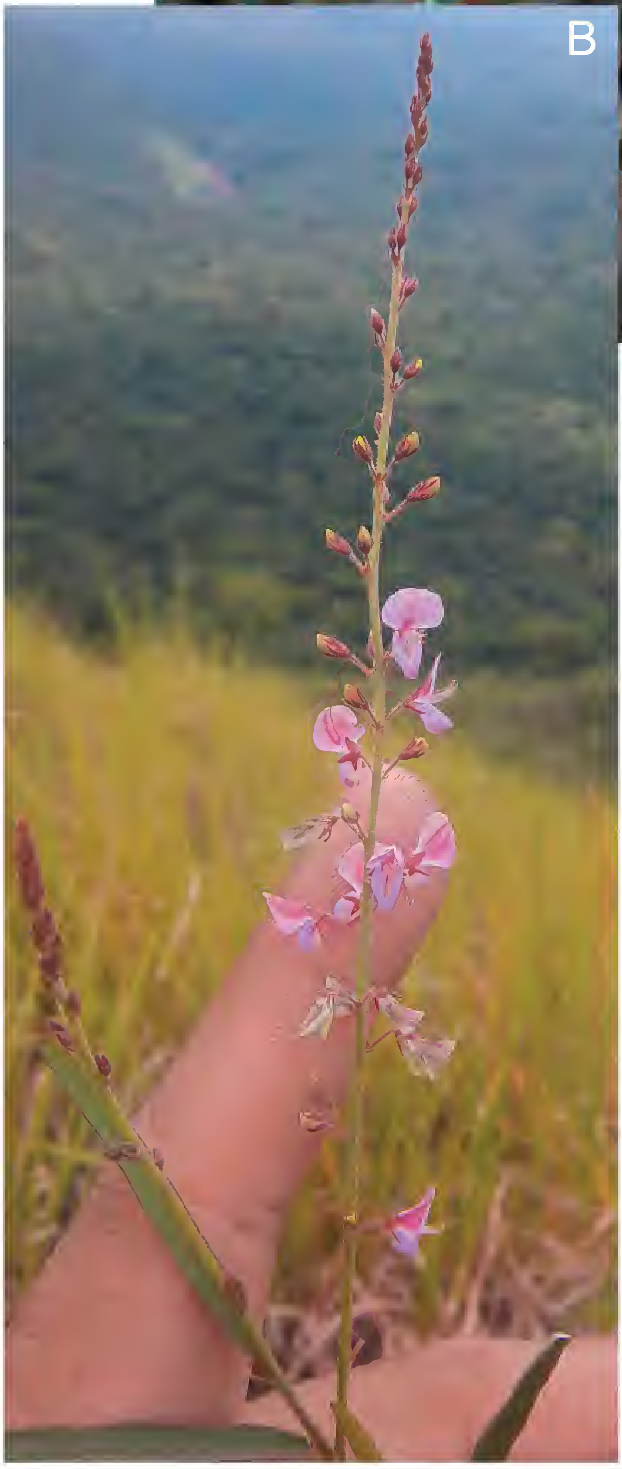

Fig. 1. **A.** Planta con flores, colectada en A.N.P. San Marcelino. **B.** Planta con flores y frutos colectada en A.N.P. La Ermita.

Para El Salvador, los sitios de colecta fueron: Santa ana: Bosque de robles; en Sonsonate: zona abierta, revestida por pastizales y con árboles distantes de *Pinus*; según MARN 2011, corresponde al ecosistema denominado: *Flujo de lava con escasa vegetación*. En el segundo sitio, Morazán, predominan los pastizales y áreas semiabiertas con presencia de *Pinus* y *Quercus*; predominando el estrato arbóreo. Según MARN 2011, corresponde al ecosistema denominado: *Bosque tropical semideciduo mixto submontano bien drenado.*

## METODOLOGÍA

Siguiendo el protocolo de recolecta científica, realizado por el personal técnico del herbario del Jardín Botánico La Laguna, se realizaron giras de campo periódicas; con el fin de incrementar la colección de referencia florística a nivel nacional.

En agosto de 2012, se visitó al Área natural protegida Complejo San Marcelino; ubicada entre los departamentos de Sonsonate (Sectores: El Chino-Teshcal y Bosque Las Lajas) y Santa Ana (Sectores La Presa) en la zona occidental. La primera

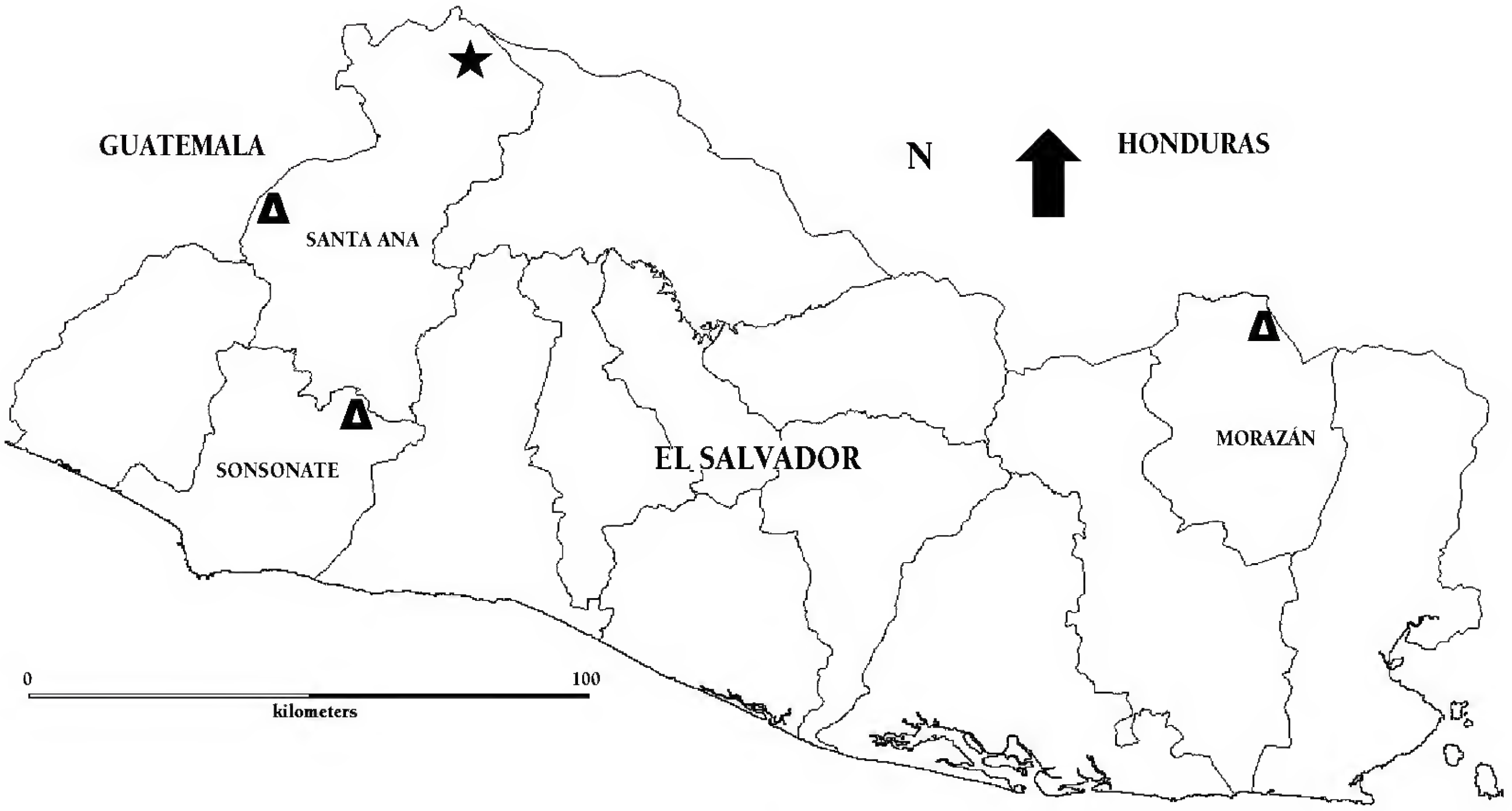

Fig. 2. Ubicación de los sitios de recolecta. Δ Nuevos sitios de registro. ★ Primer registro (O. Rohweder).

colecta de *D. angustifolium*, fue en sector El Chino. En octubre de 2013, se visitó el Área natural protegida La Ermita; al nororiente del departamento de Morazán, donde se registró la segunda colecta.

Se revisaron ejemplares de *Desmodium* en los herbarios LAGU y MHES, encontrando material colectado únicamente en LAGU. Complementando la consulta en las bases de datos de los sitios Web: Tropicos.org, JSTOR Global Plants y Field Museum of Chicago.

Material examinado: **EL SALVADOR: Santa Ana:** Municipio Candelaria de la Frontera, Cerro El Yupe, vegetación de robles, 28 Oct 1993, *J.L. Linares & C.A. Martínez 914* (EAP); *J.L. Linares & C.A. Martínez 924* (EAP); 06 Oct 1996, *J.L. Linares 3652* (EAP, MEXU); Municipio Metapán, Parque Nacional Montecristo, Mojón del Nance a una altitud de 1186 m.s.n.m. entre las coordenadas 14°21'36.65"N 89° 23'45.98"W, 03 Sep 2015, P. Galán & S. García 3417 (LAGU). **Sonsonate:** Municipio Izalco, Cantón Las Lajas, A.N.P. Complejo San Marcelino, Sector El Chino, Cima de Cerro El Chino, a una altitud de 1206 m.s.n.m. entre las coordenadas 13°48'35"N, 89°35'22"W, 16 Ago 2012 (fr), *P. Galán, A. Ibáñez, & O. Santamaría 1840* (INB, LAGU, MEXU). **Morazán:** Municipio Joateca, Cantón El Tizate, A.N.P. La Ermita, alrededores de terrenos de Asociación Administradora de Agua Potable y Saneamiento Ambiental (ASAPSMA), a una altitud de 1061 m.s.n.m. entre las coordenadas 13°55'57"N, 88°4'27"W, 09 Oct 2013 (fl, fr), *P. Galán & D. Rodríguez 2542* (B, INB, LAGU, MEXU, MHES, MO).

## DISCUSIÓN

Standley y Steyermark (1946) reportan *D. angustifolium*, desde México hasta Colombia; entre los 100 y 200 m.s.n.m. Considerada una especie poco conspicua y ampliamente distribuida en Guatemala; en El Salvador es conocida como “lengua de pájaro”.

Schubert (1965) describe el género *Desmodium* en Flora of Panama; entre ellos *D. angustifolium*, con distribución desde México hasta el norte de Sur América.

Sosa y Gómez-Pompa (1994), en su Lista Florística de “Flora de Veracruz”; reportan *D. angustifolium* y 48 especies más de *Desmodium*, para esa región del atlántico mexicano.

Estrada Castillón et al. (2004) realizaron un estudio de las leguminosas en el centro del Estado de Nuevo León, México; siendo *Desmodium*, uno de los géneros con mayor número de especies; 11 en total, entre ellas *D. angustifolium*.

Zamora (2010) reporta para Costa Rica *Desmodium angustifolium* var. *angustifolium*, en Bosques húmedos y muy húmedos a elevaciones entre 750 y 1450 m.s.n.m.; haciendo mención que se puede distinguir de otras especies por sus hojas unifoliadas.

## CONCLUSIONES

*Desmodium angustifolium*, probablemente podría registrarse en otras localidades con hábitats similares; para lo cual se tienen que hacer investigaciones minuciosas. Por otra parte, existe un alto grado de fragmentación y deterioro en áreas privadas y estatales que poseen hábitat adecuado para su desarrollo. Tomando en cuenta la distribución restringida y el escaso material colectado, se puede sugerir como una especie con prioridad de conservación en el país.

## AGRADECIMIENTOS

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# *ARACHIS GLABRATA* (FABACEAE) NEW TO THE FLORA OF LOUISIANA, U.S.A.

Charles M. Allen

*Colorado State Univ., Fort Polk Station*
*1645 23rd St.*
*Fort Polk, Louisiana 71459, U.S.A.*

## ABSTRACT

Rhizome peanut (*Arachis glabrata* Benth.) (Fabaceae) is reported new to Louisiana and increases the number of states for this introduced species to four (Alabama, Florida, Georgia, and Louisiana).

## RESUMEN

El cacahuet de rizoma (*Arachis glabrata* Benth.) (Fabaceae) se cita como nuevo para Louisiana e incrementa a cuatro el número de estados de esta especie introducida (Alabama, Florida, Georgia, y Louisiana).

Rhizome peanut (*Arachis glabrata* Benth.) (Fabaceae) is a native of southern Brazil, Paraguay, and extreme northeastern Argentina (Krapovikas & Gregory 2007) that was apparently first introduced into the United States in Florida (Isley 1990, 1998). This species has also been reported from Georgia (Carter et al. 2009) and Alabama (Keener 2012). A recent collection from New Orleans is apparently the first report for Louisiana. The current distribution map in the USDA Plants Database (http://plants.usda.gov/plants) and BONAP (Kartesz 2015) do not include Louisiana.

Voucher specimens: **LOUISIANA. Orleans Parish:** yellow flowers, locally abundant in soil area between sidewalk and building at 7446 Garfield St., New Orleans, Louisiana, 20 Jun 2015, *Charles Allen 22905* (LSU, BRIT, TEX-LL).

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# ANNOUNCEMENTS

## 2015 DELZIE DEMAREE TRAVEL AWARD RECIPIENT

The 27th Annual Delzie Demaree Travel Award was presented at the 62nd Annual Systematics Symposium (8–10 Oct 2015) at the Missouri Botanical Garden, St. Louis. One student was presented the Travel Award: Megan Ruffley, University of Idaho.

The 2015 Travel Award was underwritten by 1) Contributors to the Delzie Demaree Travel Award Endowment, and 2) Members of the Delzie Demaree Travel Award Committee.

Anyone interested in making a contribution to Delzie Demaree Endowment Fund, which supports the travel award, may make contributions by VISA or MasterCard or by a check, payable to Botanical Research Institute of Texas, to Barney Lipscomb, 1700 University Drive, Fort Worth, TX 76107-3400, U.S.A. 1-817-332-7432; Email: barney@brit.org. Thank you.

## THE 2016 APPLICATIONS FOR THE DELZIE DEMAREE TRAVEL AWARD

Applications for the 2016 Delzie Demaree Travel Award should include a letter from the applicant telling how symposium attendance will benefit his/her graduate work and letter of recommendation sent by the major professor. Please send letters of application to: Dr. Donna M.E. Ware, P.O. Box 8795, Herbarium, Biology Department, The College of William and Mary, Williamsburg, Virginia 23185-8795, U.S.A. 1-757-221-2799; Email: dmeware@verizon.net. Applications may also be sent to: Barney Lipscomb, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A. 1-817-332-7432; Email: barney@brit.org. The period for receiving applications will end three weeks prior to the date of the symposium if a sufficient number of applications are in hand at that time. Anyone wishing to apply after that date should inquire whether applications are still being accepted before applying. The Systematics Symposium dates for 2016 are 14–15 October 2016 (dates tentative and subject to change).

The Delzie Demaree Travel Award was established in 1988 honoring **Delzie Demaree** who attended 35 out of a possible 36 symposia before he died in 1987. Delzie Demaree was a frontier botanist, explorer, discoverer, and teacher. His teaching career as a botanist began in Arkansas at Hendrix College in 1922. He also taught botany at the University of Arkansas, Navajo Indian School, Yale School of Forestry, Arkansas A&M, and Arkansas State University at Jonesboro where he retired as professor emeritus in 1953. One of the things he enjoyed most as a botanist was assisting students with their field botany research.

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# NEW CO-OCCURRENCE OF *SCHOENOPLECTIELLA HALLII* AND *S. SAXIMONTANA* (CYPERACEAE) IN OHIO (U.S.A.): CONSERVATION IMPLICATIONS FOR BOTH SPECIES

Paul M. McKenzie

*U.S. Fish and Wildlife Service*[1]
*101 Park DeVille Dr.; Suite A*
*Columbia, Missouri 65203, U.S.A.*
*paul_mckenzie@fws.gov*

Daniel W. Boone

*3228 Hanna Ave.*
*Cincinnati, Ohio 45211, U.S.A.*

Marian Smith

*Department of Biology*
*Southern Illinois University*
*Edwardsville, Illinois 62026, U.S.A.*

Richard L. Gardner

*Ohio Department of Natural Resources*
*Division of Natural Areas and Preserves*
*2045 Morse Road C-3*
*Columbus, Ohio 43229, U.S.A.*

## ABSTRACT

An examination of achenes from specimens of *Schoenoplectiella saximontana* collected at a Pickaway County, Ohio, site in 2011 led to the discovery of *Schoenoplectiella hallii* at the same locality. How long *S. hallii* has been at the only known site for *S. saximontana* in Ohio is unknown, but is speculated to be of recent occurrence due to the lack of evidence of hybridization between the two species at this location. It is surmised that the appearance of *S. hallii* at the Ohio site was due to achene dispersal by migrating waterfowl from established sites in Indiana, Illinois, Kentucky, or Michigan. The presence of *S. hallii* and *S. saximontana* at the Pickaway County site may eventually lead to hybridization between the two species, as documented elsewhere within their range, threatening the conservation status of both species in Ohio. Further monitoring of this site is warranted and additional surveys for both species in Ohio are recommended in areas that may provide suitable habitat. It is also recommended that surveys be conducted at sites in North America that have either *S. saximontana* or *S. hallii*. In cases where one species greatly outnumbers another, it is recommended that numerous plants be examined from different portions of the population to detect the rarer species.

## RESUMEN

Un examen de los aquenios de especimenes de *Schoenoplectiella saximontana* colectados en un lugar del Condado de Pickaway, Ohio, en 2011 dio lugar al descubrimiento de *Schoenoplectiella hallii* en la mismo localidad. No se sabe cuanto tiempo ha estado *S. hallii* en el único lugar conocido de *S. saximontana* en Ohio, pero se especula que sea una ocurrencia reciente debido a la falta de pruebas de hibridación entre las dos especies en esta localidad. Se supone que la aparición de *S. hallii* en este lugar de Ohio fue debida a la dispersión de aquenios por aves acuáticas desde puntos de Indiana, Illinois, Kentucky, y Michigan. La presencia de *S. hallii* y *S. saximontana* en el Condado de Pickaway puede dar lugar a hibridación entre las dos especies, como se ha documentado en otras partes, amenazando el status de conservación de ambas especies en Ohio. Se necesita más control en este lugar y se recomiendan estudios adicionales de ambas especies en Ohio en áreas que puedan tener hábitats adecuados. También se recomienda que se realicen estudios en otros lugares de Norte América que tengan *S. saximontana* o *S. hallii*. En los casos en que una especie sobrepase mucho en número a otra, se recomienda que se examinen numerosas plantas de diferentes partes de la población para detectar la especie más rara.

## INTRODUCTION

*Schoenoplectiella hallii* (A. Gray) Lye and *S. saximontana* (Fernald) Lye are sedge species that were once thought to be allopatric, with *S. hallii* occurring primarily in the Midwest and eastern U.S. and *S. saximontana* largely confined to the western portions of the country (Gleason & Cronquist 1991; Beatty et al. 2004). *Schoenoplectiella hallii* has a global ranking of G2/G3 (imperiled/vulnerable): It is listed as "critically imperiled" in seven of the 10 states in which it is known to be extant, "imperiled" in two, and "imperiled/vulnerable" in one. Her-

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**[1]The findings and conclusions in this article are those of the author(s) and do not necessarily represent the views of the U.S. Fish and Wildlife Service.**

**Dedication:** This paper is dedicated to the memory of Galen Smith whose love and appreciation of the Cyperaceae was a constant source of inspiration to us. He had a deep conservation concern for members of this family that were threatened with extinction. He was one of true classical taxonomists who understood the importance of morphology, life history ecology, and natural community/habitat dynamics in separating one species from another. He will be greatly missed.

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barium records indicate that it had been reported from GA in 1966, MA in 1931 and IA in 1890 (McKenzie et al. 2007), but these populations were "possibly or likely extirpated" (NatureServe 2015; McKenzie et al. 2007). Although *S. hallii* is reported on NatureServe (2015) as "not ranked/under review" in South Carolina, McKenzie et al. (2007) state that previous reports of *S. hallii* in SC are based on misidentification of *S. erecta*.

*Schoenoplectiella saximontana* has a global ranking of G5 (secure) (NatureServe 2015), but it is listed as S1 (critically imperiled) in British Columbia as well as in 7 of the 12 states where it occurs and S3 (vulnerable) in TX. It has not been ranked or is under review in CA, OK, and SD. It has been reported from two states in Mexico (Smith 2002a). Throughout its range, *S. saximontana* is considered to be an uncommon species whose distribution is scattered (Smith 2002a; NatureServe 2015).

*Schoenoplectiella saximontana* was first collected in Pickaway County, Ohio, by Bartley and Pontius in 1936 (*OS #3241, #3242, #3243*) (https://herbarium.osu.edu/online-data-access; accessed 17 Jan 2015) (Schaffner 1937) and subsequently collected at the same site nine times between 1948 and 2008 by several botanists (http://128.146.250.9/bol/herbarium/Results#; accessed 17 Jan 2015). Most recently, it was collected 7 Aug 2011 by Dan Boone [*Boone 8-7-1229-11* (MO)]. Prior to this report there are no records of *S. hallii* for Ohio at this or any other locality in the state (Schaffner 1937).

### Pickaway County Site History

The Pickaway County site is located south of Circleville, Ohio, and historically was within a few kilometers or adjacent to the "Pickaway Plains" native tall grass prairie that was estimated to be 4.8 km long and 11.2 km wide. This prairie, however, was converted to cropland, and no remnant of this natural community currently exists. When the site was first botanized by Floyd Bartley in 1936, he named the collection site "George Hitler's Pond" after George Hitler who owned the property and whose family originally settled the area in 1799. In the 1940s, the Hitler family sold the property to the List family who subsequently sold the farm in 2013 to the Appalachia Ohio Alliance, a non-profit conservation organization. The site is now preserved as part of the 95-acre Floyd Bartley Nature Preserve (Gibbons 2014).

### Site Characteristics

The terrain of the general area is gentle, rolling, glacially formed hills with depressions ranging in size from <0.4 ha to 1 ha. The glacial deposits are Wisconsin age. The soils of Hitler Pond are deep, poorly drained soils on outwash plains formed over ice contact depositions, with stratified sand and gravel layers. Permeability is moderately slow in the subsoil but rapid in the substratum (USDA 1980); the slope is 0 to 2 percent. As elsewhere throughout the range of *S. hallii*, the Pickaway County site is cultivated when dry, but during wet cycles the ponded water prevents the use of farm equipment necessary for crop production. In years when water is present at the site, ponding occurs from February to early June (USDA 1980).

Plant associates documented at the site include: *Abutilon theophrasti* Medik., *Amaranthus albus* L., *Ammania robusta* Heer and Regel, *Cyperus esculentus* L., *Echinodorus berteroi* (Spreng.) Fassett, *Echinochloa crusgalli* (L.) Beauv., *Eclipta prostrata* (L.) L., *Eleocharis engelmannii* Steud., *E. obtusa* (Willd.) Schult., *Eragrostis hypnoides* (Lam.) BSP., *Gratiola neglecta* Torr., *Lindernia dubia* (L.) Pennell, *Mollugo verticillata* L., *Morus alba* L. (seedlings), *Packera glabella* (Poir.) C. Jeffrey, *Populus deltoides* Bartram ex Marshall (seedlings), *Rorripa palustris* (L.) Bresser, *R. sessiliflora* (Nutt.) Hitchc., *Rotala ramosior* (L.) Koehne, *Sida spinosa* L., and *Symphyotrichum lanceolatum* (Willd.) G.L. Nesom.

### Circumstances surrounding the discovery of *S. hallii* at the Pickaway County site

On 30 Sep 2014, Boone delivered specimens of *Schoenoplectiella saximontana* to the senior author, who broke the bundle into five separate sheets, shattered the spikelets from a few isolated culms to create achene packets, and observed that some of the achenes were two-sided rather than 3-sided as would be characteristic of *S. saximontana* (Smith & McKenzie 2011). Upon closer examination with a hand lens, McKenzie confirmed that they were achenes of *S. hallii*. After removing the specimens from the plant press, he examined all culms to determine the source of the 2-sided achenes and located two specimens of *S. hallii* entwined with *S. saximontana* culms. The diagnostic difference in achene structure of the two species is depicted in Figure 1. For SEMs of achene cross sections see Smith and McKenzie (2011).

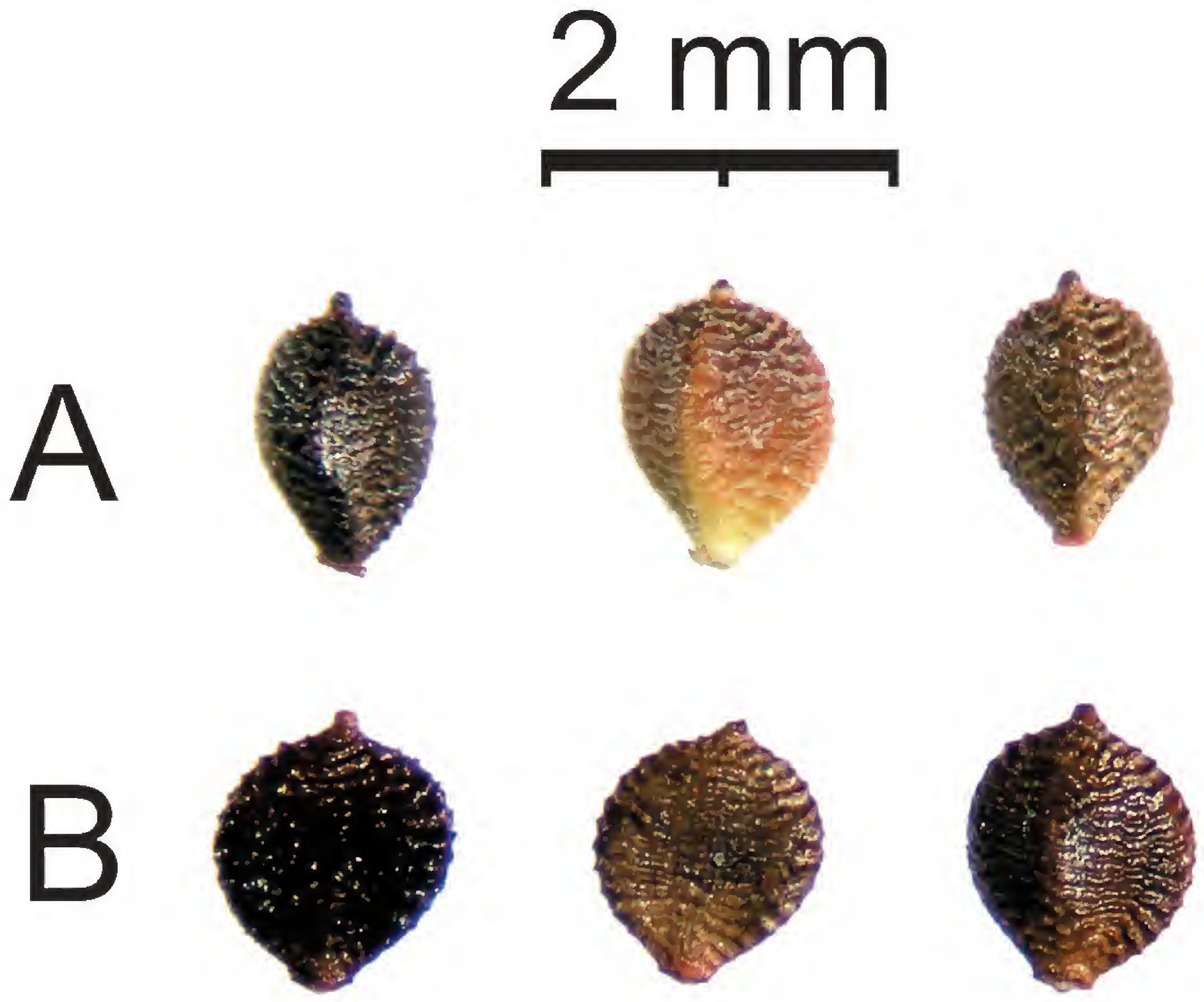

**Fig. 1. Comparison of 3-sided achenes of *S. saximontana* (A) from *Dan Boone 8-7-1229* and 2-sided achenes of *S. hallii* (B) from *Dan Boone 8-7-1230*. In row A, note the prominent midrib in *S. saximontana*, which creates its distinctive trigonous cross section. See cross sections of achenes (Smith & McKenzie 2011).**

The following voucher specimens represent the first documented record of *S. hallii* for Ohio.

MISSOURI BOTANICAL GARDEN
PLANTS OF OHIO

### *Schoenoplectiella hallii* (A. Gray) Lye

**U.S.A. Ohio. Pickaway Co.:** Floyd Bartley Nature Preserve, ca. 0.58 mi SW of the inter. of Rts. 41 and 56, or ca. 0.49 mi SSE of the inter. of Rts. 68 and 56, and ca. 1.2 mi SE of Circleville; 39°34'43.66"N, 82°55'11.84"W; NE ¼ Section 32, Circleville Township; elev. 707'. Two plants mixed in a large population of *S. saximontana* in wet depression of agricultural field. Discovery made during examination of achenes by Paul McKenzie on 29 Sep 2014; in association with *Ammannia robusta, Echinodorus berteroi, Eleocharis englemannii, E. obtusa, Gratiola neglecta, Lindernia dubia, Rorippa palustris, R. sessiliflora,* and *Rotala ramosior*. First record for Ohio, 7 Aug 2011, *Dan Boone 8-7-1230-11*.

MISSOURI BOTANICAL GARDEN
PLANTS OF OHIO

### *Schoenoplectiella saximontana* (Fernald) Lye

**U.S.A. Ohio. Pickaway Co.:** Floyd Bartley Nature Preserve, ca. 0.58 mi SW of the inter. of Rts. 41 and 56, or ca. 0.49 mi SSE of the inter. of Rts. 68 and 56, and ca. 1.2 mi SE of Circleville; 39°34'43.66"N, 82°55'11.84"W; NE ¼ Section 32, Circleville Township; elev. 707'. Hundreds of thousands of plants in wet depression of agricultural field; in association with *Ammannia robusta, Echinodorus berteroi, Eleocharis englemannii, E. obtusa, Gratiola neglecta, Lindernia dubia, Rorippa palustris, R. sessiliflora, Rotala ramosior,* and *Scheonpolectiella hallii*; 7 Aug 2011, *Dan Boone 8-7-1229-11*.

The sole voucher specimen of *S. hallii* from the Pickaway County, OH, site is housed at the Missouri Botanical Garden (accession no. MO-2443050 6604784) (Tropicos database: http://www.tropicos.org/Specimen/100755931). One Pickaway County specimen of *S. saximontana* is at MO (accession no. MO-2443051 6604783) (Tropicos database: http://www.tropicos.org/Specimen/100755932). Duplicates of *Dan Boone 8-7-1229-11* are deposited at CSCN, MICH, OKL, and UWW.

### 2014 field search of Pickaway County site and examination of herbarium collections

In 2014, Rick Gardner surveyed the site to determine if *S. hallii* and *S. saximontana* were present. He found an abundance of *S. saximontana* but, no evidence of *S. hallii*, as had been documented in 2011. The inability to rediscover *S. hallii* at the site may be due to the absence of plants in 2014 or the difficulty in finding the species among the thousands of culms of *S. saximontana*. Boone and McKenzie examined all culms of duplicates from Boone's 2011 collection of *S. saximontana* and were unable to find any additional specimens or achenes of *S. hallii*. In 2014 and 2015, Gardner examined specimens of *S. saximontana* collected between 1936 and 2008 at the Pickaway County site housed at the Ohio State University (OS) herbarium and was unable to confirm any additional specimens of *S. hallii* among the specimens of *S. saximontana*. These observations suggest that either *S. hallii* is of recent occurrence at the Pickaway County site or has been overlooked due to its rarity at this locality.

Smith and McKenzie (2011) reported similar fluctuations in species composition for sites of *S. hallii* and *S. saximontana* near Lawton, Oklahoma, on the Wichita Mountains Wildlife Refuge (WMWR) and adjacent areas on the Fort Sill Military Reservation (FSMR). During their studies between 2001 and 2013 (see, in part, Smith & McKenzie 2011, 2013), there were sites where they observed only one of the species; however, either the second species had been documented previously at each site and/or the achenes were present in the seed bank. The number of individuals of either species varied significantly from year to year. During some years one species in low numbers would be difficult to find among the tens of thousands of plants of the second species. In 2012, Robert Steinauer discovered *S. saximontana* at a site in Loup County, Nebraska, where previously only *S. hallii* had been documented. A survey of the same site by Steinauer, Smith, and McKenzie on 4 Aug 2014 documented *S. hallii* but not *S. saximontana*. Since 2004 (Smith et al. 2004), the hybrid, *Schoenoplectiella ×magrathii* (Smith & McKenzie 2013), has been reported at the OK sites in densities that fluctuate annually.

### Origin of *S. saximontana* and *S. hallii* at the Pickaway County site

The origin of *S. saximontana* at the Pickaway County, OH, site has been an issue of debate. Because *S. saximontana* at this site is the only documented locality for this species east of the Mississippi River (Smith 2002a), some (e.g., Stuckey & Roberts 1982) have postulated that it was adventive from hay transported from the western United States where the species is of more regular occurrence. We agree with others, however, who have suggested migrating waterfowl as the natural dispersal agent responsible for the appearance of *S. saximontana* at the Pickaway County site. DeVlaming and Proctor (1968) discovered that ducks and killdeer ingest and disperse viable achenes of a number of *Scirpus* species, and Gleason and Cronquist (1964) suggested that the primary method for long-range dissemination of aquatic species is by attachment of achenes to feathers, bills, or feet of migrating waterfowl. Vivian-Smith and Stiles (1994) examined 36 species of waterfowl and reported that 78% of the birds had seeds of wetland plants adhering to their feathers or feet. Additionally, other authors have demonstrated that achenes with hardened seed coats can remain viable after passing through the digestive tract of migrating waterfowl (DeVlaming & Proctor 1968; Powers et al.1978; Figuerola & Green 2002). Others have reported the ability of migratory species of birds to transport seeds long distances externally and internally (Proctor 1968 and see review in Nathan et al. 2008).

*Scirpus* species are particularly adapted for both internal and external transport because of their diminutive size and hard seed coats (Krefting & Roe 1949; DeVlaming & Proctor 1968). In Illinois, Oklahoma, and Texas, dispersal of *Schoenoplectiella* is assumed to be facilitated by migrating waterfowl (McClain et al. 1997; Magrath 2002; McKenzie et al. 2007; Smith & McKenzie 2013) as well as some ungulates, including bison (Rosas et al. 2008). Some species of waterfowl have been known to fly 1200 km in less than 24 hrs (Preben Clausen, pers. comm.in Figuerola & Green 2002), and the Pickaway County site is between approximately 371 and 611 km from known sites of *S. hallii* in Illinois, Indiana, Kentucky, or Michigan. Consequently, achenes of *S. hallii* could be transported in less than one day by migrating birds between other states with extant sites for the species and the Ohio locality. As with *S. saximontana,* we believe that migrating waterfowl were likely responsible for the presence of *S. hallii* at the Pickaway County site, and both species should be considered native to the state.

### Relationship of groundwater to the creation of habitat for *Schoenoplectiella*

*Schoenoplectiella hallii*, *S. saximontana,* and *S. ×magrathii* are obligate wetland taxa that have similar habitat requirements: most often sandy, rocky, or gravelly soil, occasionally clay, around the margins of ponds, ditches, and swales with fluctuating water levels, and a scarcity of other vegetation as competitors (McClain et al. 1997; Smith 2002a; McKenzie et al. 2007; Smith & McKenzie 2013). In Mason County, Illinois, McKenzie et al. (2010) linked population size and location to a rise in the Illinois River and a concomitant rise in groundwater that created temporary ponds. Smith (2001, 2002, 2003) conducted a 3-year study in Scott County, Missouri, and illustrated the dependence of seedling establishment in *S. hallii* on the presence of groundwater within 1 m of the soil surface and the maintenance of soil moisture at >10%, but less than 100%. Some populations in Oklahoma contain individuals of all three taxa (Smith & McKenzie 2013), suggesting that they share the same habitat requirements.

The lack of appearance of *S. saximontana* at the Pickaway County site between the early 1990s and 2008, despite repeated trips to the locality to locate the species (Jim McCormac, pers. comm. 2015; Boone pers. obs.), suggest that the availability of suitable habitat from year to year may be due to multiple factors. Walker et al. (1965) conducted an analysis of groundwater in areas adjacent to the Scioto River Valley that include the Bartley Preserve and determined that the permeable sand and gravel deposits in the valley provided one of the most important sources of large groundwater supplies in Ohio. The authors concluded (Walker et al. 1965:15) that “natural recharge in the Scioto valley occurs from precipitation, from ground water flowing from the bedrock at the edges of the valley, and from the Scioto River when it is in flood stage.”

Groundwater and the underlying aquifers are being depleted throughout the United States. In a study of 40 U.S. aquifers, Konikow (2013) determined that aquifer depletion totaled ca. 1000 km$^3$ from 2000 to 2008 and that the rate increased dramatically after 1950. The aquifer systems with the highest loss include areas where *Schoenoplectiella hallii* and *S. saximontana* are most abundant: the High Plains aquifer (340.9 km$^3$), the Mississippi embayment aquifer system (182.0 km3), and the Central Valley aquifer system of California (144.8 km$^3$) (Konikow 2013). Zekster et al. (2005) reported that groundwater depletion results in a decline in surface water and stream flow, and Sophocleous (2002) indicated that such diminutions impact the ecological integrity of wetlands, resulting in significant loss of habitat and biodiversity. As reported by Smith (2003) for *Schoenoplectiella hallii* populations in Missouri, Burke et al (1999) suggested that many environmental factors rely on the accessibility of underlying groundwater remaining within a few meters of the surface, rather than on the volumetric amount of groundwater theoretically available from deep aquifers. Therefore, wetlands, transient surface ponds, and stream flows may dry up even when the stored groundwater in a basin remains large.

The hydrological influences on available habitat at the Pickaway County site are not fully understood and need further study. During years of above-average precipitation, suitable habitat may be present due to above ground ponding of water or influenced by a rise in an underground aquifer levels. The impact of water withdrawals from underground aquifers for agricultural, industrial, or residential uses may be a factor in the availability of habitat. During years of below-average precipitation, the added impact of water withdrawn for irrigation and other uses may prevent the formation of ponded water necessary for germination and growth (Baskin et al. 2003). Such impacts may not be realized during years when there is an abundant water supply.

Walker et al. (1965) noted that groundwater within the Scioto River Valley flowed from the river to adjacent sand and gravel deposits and suggested that well pumping could cause a reversal in flows. The amount of groundwater recharge from the Scioto River is dependent upon “the condition of the river bottom, permeability of the unconsolidated material, thickness of the aquifers, and the distance and ground-water gradient between the wells and the source of recharge” (Walker et al. 1965:15). Evidence that this aquifer may be impacted due to water withdrawals for industrial use is supported by observations of land owners who live in the vicinity. The RCA-Thompson plant withdrew an estimated 1 million gallons of water a day when it was in operation through 2004, and neighbors noted that water levels in the area were noticeably lower than in the years prior to the plant's construction and operation (Steve Fleegal, pers. comm., Mar 2015). Reduced water levels due to water demands by the plant could explain the lack of observations of *S. saximontana* between the early 1990s and 2007. Observations of *Schoenoplectiella* spp. at the Bartley Preserve in 2008, 2011, and 2014 were after the RCA-Thompson plant closed in 2004 (http://www.epa.ohio.gov/cdo/rca.aspx). With increased needs of groundwater in the area for commercial, industrial, residential, and recreational uses, further research is needed to determine the impacts of these demands on habitat availability on the Bartley Preserve. The Appalachia Ohio Alliance recently received an EPA research grant to study the hydrology of the site, and the project is anticipated to start this year and may provide additional insights into the issue (Fleegal, pers. comm. Feb 2015).

### Conservation implications of co-occurrences of *Schoenoplectiella hallii* and *S. saximontana*

Magrath (2002) conducted surveys for *S. hallii* and *S. saximontana* at multiple sites on the WMWR in Oklahoma in 2000 and found both species at 20 of the 134 sites that he searched. In 2001, Marian Smith discovered suspected hybrids between *S. hallii* and *S. saximontana* at the same refuge, and this supposition led to an extensive survey by Smith and McKenzie on the WMWR and adjacent areas of FSMR between 2002 and 2013 (see, in part, Smith & McKenzie 2011, 2013). These investigations resulted in the documentation of the first reported hybrid between the two species that included confirmation by genetic analysis (Smith et al. 2004; Smith & McKenzie 2011, 2013; Esselman et al. 2012). The hybrid was formally described as *Schoenoplectiella ×magrathii* Smith and McKenzie (Smith & McKenzie 2013). Smith and McKenzie (2011, 2013) outlined the potential adverse impacts of hybridization on the conservation of both *S. hallii* and *S. saximontana*. As is the case in Oklahoma, the co-occurrence of *S. hallii* and *S. saximontana* in the same population in Ohio may result in the development of a hybrid swarm, which could threaten both species. Three additional states have sites where there are mixed populations (NatureServe 2015): Kansas (Craig Freeman pers. comm. 2006), Texas (Bob O'Kennon, pers. comm. 2007), and Nebraska (Robert Steinhauer, pers. comm. 2012). Although *S. saximontana* occurs in eight counties in Oklahoma, it is known to co-occur with *S. hallii* and the hybrid *S. ×magrathii* in only Comanche County (Smith & McKenzie 2013; Oklahoma Vascular Plant Database 2015). It is not yet known if the hybrid occurs in the Pickaway County site in Ohio, but co-occurrence of *S. hallii*, *S. saximontana* and the hybrid *S. ×magrathii* at sites in Oklahoma would suggest that it is possible.

*Schoenoplectiella saximontana* has been known from a number of populations in south Texas for many years, but the presence of *S. hallii* in the LBJ Grasslands in North Texas was not reported until 2004 (O'Kennon & McLemore 2004). Subsequently, both species were discovered in 2007 at Rhodes Lake, Decatur County (O'Kennon, pers. comm. 2012). As it is less than 193 km from Rhodes Lake to the populations in Comanche County, Oklahoma, it is plausible that migrating waterfowl could have dispersed seeds from these earlier-established populations to north Texas. Additional *S. hallii* and *S. saximontana* sites have been discovered on the LBJ Grasslands recently, with some individuals having both 2- and 3-sided achenes (O'Kennon, pers. comm. 2012). In addition, *S. saximontana* populations containing apparent hybrids were found at Enchanted Rock State Natural Area in south-central Texas in 2012 (O'Kennon, pers. comm.).

Since 1999, numerous new populations of *S. hallii* have been reported in Nebraska, and a large population containing both species was discovered there in 2012 (Robert Steinhauer, pers. comm. 2015). Specimens of *S. hallii* and *S. saximontana* taken in 2012 by Steinhauer were examined by McKenzie and Smith in 2014, and no evidence of hybrids was discovered. A trip to the same site in 2014 by Steinhauer, Smith, and McKenzie yielded specimens of *S. hallii* but not *S. saximontana*. Based on observations by Smith and McKenzie in Oklahoma, however, the appearance of the hybrid *S. ×magrathii* may not be immediate. McKenzie and Smith examined specimens collected by Magrath in 2000 and reported in Magrath (2002) but saw no evidence of hybrids. A field investigation by Smith in 2001, however, led to the initial observation of possible hybrids (Smith & McKenzie 2011). No hybrids were reported at Rhodes Lake, Texas, in 2007 where both species were recorded, but within five years evidence of hybridization was observed by O'Kennon (pers. comm. 2012). Given these observations, it is predictable that *S. ×magrathii* may occur in Nebraska and Ohio. In a report of the status of hybrids in Oklahoma, Smith and McKenzie (2013) postulated that *S. ×magrathii* can displace and out-compete the parental species under certain environmental conditions. During their investigations between 2001 and 2012 (Smith & McKenzie 2011, 2013), they observed notable changes in the abundance of the parental species and the hybrid, and noted that in some years *S. ×magrathii* greatly outnumbered either *S. hallii* or *S. saximontana*.

### Recommendations for additional research

Populations of *S. hallii* and *S. saximontana* in Pickaway County, Ohio, and other states where both species co-occur should continue to be monitored to assess the appearance of hybrids. States where one species is known to occur, but not the second, should be surveyed to search for the presence of the other. Because one species may greatly outnumber the second and the rarer species may be limited in its distribution, it is recommended that multiple individuals from a cross section of the population be examined. Finally, because the species can be difficult to distinguish morphologically, spikelets on herbarium sheets of both species should be examined for the presence of 2-sided and 3-sided achenes. The continued occurrence and spread of *S. ×magrathii* threaten the conservation and persistence of *S. hallii* and *S. saximontana*, but it is not yet known how hybrid population size varies over time, or if the hybrid can displace one or both of the parental species completely.

## ACKNOWLEDGMENTS

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# A CHECKLIST OF VASCULAR PLANTS AT THE COASTWARD EXTENT OF COASTAL PRAIRIE IN SOUTHEAST TEXAS, U.S.A.

David J. Rosen and Siavash Zamirpour
*Department of Biology*
*Lee College*
*Baytown, Texas 77522-0818, U.S.A.*
*drosen@lee.edu*

Andrew Sipocz
*Natural Resources, State Parks*
*Texas Parks and Wildlife Department*
*14200 Garrett Road*
*Houston, Texas 77044, U.S.A.*

## ABSTRACT

The Follets Island Conservation Initiative is a 179 ha parcel on Follets Island in Brazoria County, Texas. Field work from May 2013 through May 2015 produced a checklist of 130 species of vascular plants representing 41 families and 105 genera from a flora that is 98% native (species) and a protected refuge for fourteen species of conservation interest. The Follets Island site is representative of a strand prairie, a term used to describe the Gulf-shoreline extent of coastal prairie in southeast Texas.

## RESUMEN

La Follets Island Conservation Initiative es una parcela de 179 ha en la Isla Follets en el condado de Brazoria, Texas. El trabajo de campo desde mayo de 2013 hasta mayo de 2015 produjo un catálogo de 130 especies de plantas vasculares representando 41 familias y 105 géneros de una flora que es 98% nativa (especies) y un refugio protegido para catorce especies de interés de conservación. La Isla Follets es representativa de una pradera de playa, un término usado para describir la extensión la línea de costa del Golfo de la pradera costera en el sureste de Texas.

## INTRODUCTION

Conservation of coastal prairie in Texas (characterized in detail by Smeins et al. 1991) has been a priority for several decades. An important first step in the conservation of any ecosystem and a necessity for sound management decisions is the inventory of botanical resources (Prater et al. 2004). To this end, a few field surveys of the vascular plants of some of the remaining relatively large (42–120 ha) coastal prairie remnants have been published (Rosen 2007, 2010, 2014; Singhurst et al. 2014a). These field studies have also provided important botanical conservation information and progress towards compiling a more complete checklist of the vascular plants of the ecoregion. Discovery and study of additional prairie remnants and endemic habitat types throughout the coastal prairie ecoregion continues to be a priority of field botanists and prairie enthusiasts (e.g., Singhurst et al. 2014b; Rosen unpublished data). Among these sites identified by the authors is a 179 ha parcel on Follets Island in Brazoria County, Texas.

Smeins et al. (1991) describe the coastal prairie ecoregion as extending inland from the coast up to 160 km. The Follets Island site was of interest to us as its uplands supported plant species characteristic of remnant prairies over 55 km from the coast and therefore may represent the Gulf-shoreline extent of coastal prairie and a contact with other Gulf-shoreline plant communities such as dunes, salt-flats, and salt-marshes. The site also seemed to shed some light on what has been regionally referred to as "strand prairie" (Hollingsworth 1998). The origin of this local name is uncertain, but it has been used in reference to upland prairies on Texas' barrier islands and Coastal Sand Plain dominated by *Schizachyrium littorale* (Nash) E.P. Bicknell (absent on Follets Island) and *Paspalum monostachyum* Vasey (Diamond et al. 1987; Hollingsworth 1998). In the ecological context, strand refers to the shoreline of a marine environment, thus the name is fitting to describe any Gulf-shoreline prairie habitat type within the coastal prairie ecoregion. The purpose of the study presented here is to provide a checklist of vascular plants from the Follets Island site supplemented with conservation notes for some of our discoveries.

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## METHODS

Our study site is located in Brazoria County on Follets Island, a peninsula bounded by the Gulf of Mexico and Christmas Bay and approximately 52 km SW of the City of Galveston (Fig. 1). This 179 ha site was recently acquired by the Texas Parks and Wildlife Department and will be formally called The Follets Island Conservation Initiative and managed as a coastal preserve. The approximate center of this elongated site lies at 29.0196°N, 95.2010°W, and its dimensions are roughly 2.9 km long by 0.3 km wide at its narrowest point and 1.1 km wide at its widest point (Fig. 2). Prairie soils of the site (about 55 ha) are mapped as Mustang fine sand (Crenwelge et al. 1981). The climate of the site is as described for nearby Galveston Island State Park (Rosen et al. 2014). The prairies are not inundated by daily tides and occur on the uplands bounded by beach dunes at the Gulf and salt-flats and salt-marsh on the bay side (Fig. 2). Prairie vegetation also occurs on elevated circular to oblong mounds surrounded by the saline habitats (Fig 2, Fig. 3).

During ten collecting trips from May 2013 through May 2015 we focused our efforts on prairies throughout the site but collected in adjacent habitats as well. A complete set of voucher specimens collected by the first author (6043–6734 & s.n.) is housed at TEX. Collections by the second author (1–116) are housed at BRIT. Plant identifications were primarily determined using *Flora of North America* (1993+), Correll and Johnston (1970), and Gould (1975). Classification and author names follow Tropicos (2015). The native, introduced, and conservation status of each species were determined by review of *Flora of North America* (1993+), Correll and Johnston (1970), and correspondence with field botanists or specific references mentioned later.

## RESULTS & DISCUSSION

Our fieldwork produced a checklist of 130 species of vascular plants representing 41 families and 105 genera (Appendix 1; Table 1). Speciose families include Poaceae (28 spp. including two non-native), Asteraceae (16 spp.), and Fabaceae (14 spp.). The largest genus, *Dichanthelium* (Hitchc. & Chase) Gould, contains six native species. The species flora is 98% native, while non-native species all rank infrequent-rare in abundance. One family, Tamaricaceae, is represented by only one non-native species. Fourteen species are of conservation interest for their endemism, range extreme, and in some cases the discovery of populations on this protected site (Appendix 2). Eighty-six species are known from inland remnants with vegetation considered representative of coastal prairie. Five species co-occur at six other inland prairie remnants with nearly complete inventory by the first author. Thirteen species are shared with other Gulf-shoreline habitats (dunes, salt-marshes, and salt-flats). Thirty-four species do not occur at six other inland prairie remnants with nearly complete inventory by the first author (although this could be related to the area of those sites, or that the species simply remain to be discovered). Insomuch as other Gulf-shoreline habitats are not especially species rich (e.g., Table 2, Rosen et al. 2014), our study suggests the presence of coastal prairie vegetation at the Gulf-shoreline increases local plant richness (at least at this site). We encourage the continued use of the term strand prairie in conservation efforts as it emphasizes a unique and interesting phase of the Gulf-shoreline extent of coastal prairie vegetation in southeast Texas. Discovery and protection of additional strand prairie habitats in southeast Texas should accompany that of inland sites.

## APPENDIX 1: CHECKLIST

Families are arranged alphabetically, beginning with monocots and followed by eudicots. Genera, species, and infraspecific names are arranged alphabetically under families. Annotations indicate native species common to (§) or not collected from (♦) any of six other inland prairie remnants with nearly complete inventory by the first author, non-native species (*) and notes detailing species of conservation interest (1-14). Following each name is an abbreviation representing a frequently used scale of the relative abundance of that species: **r** = rare (very difficult to find and limited to one or very few locations or uncommon habitats); **i** = infrequent (difficult to find with few individuals or colonies but found in several locations); **o** = occasional (widely scattered but not difficult to find); **f** = frequent (easily seen or found in one or more common habitats but not dominant in any common habitat); and **a** = abundant (dominant or co-dominant in one or more common habitats).

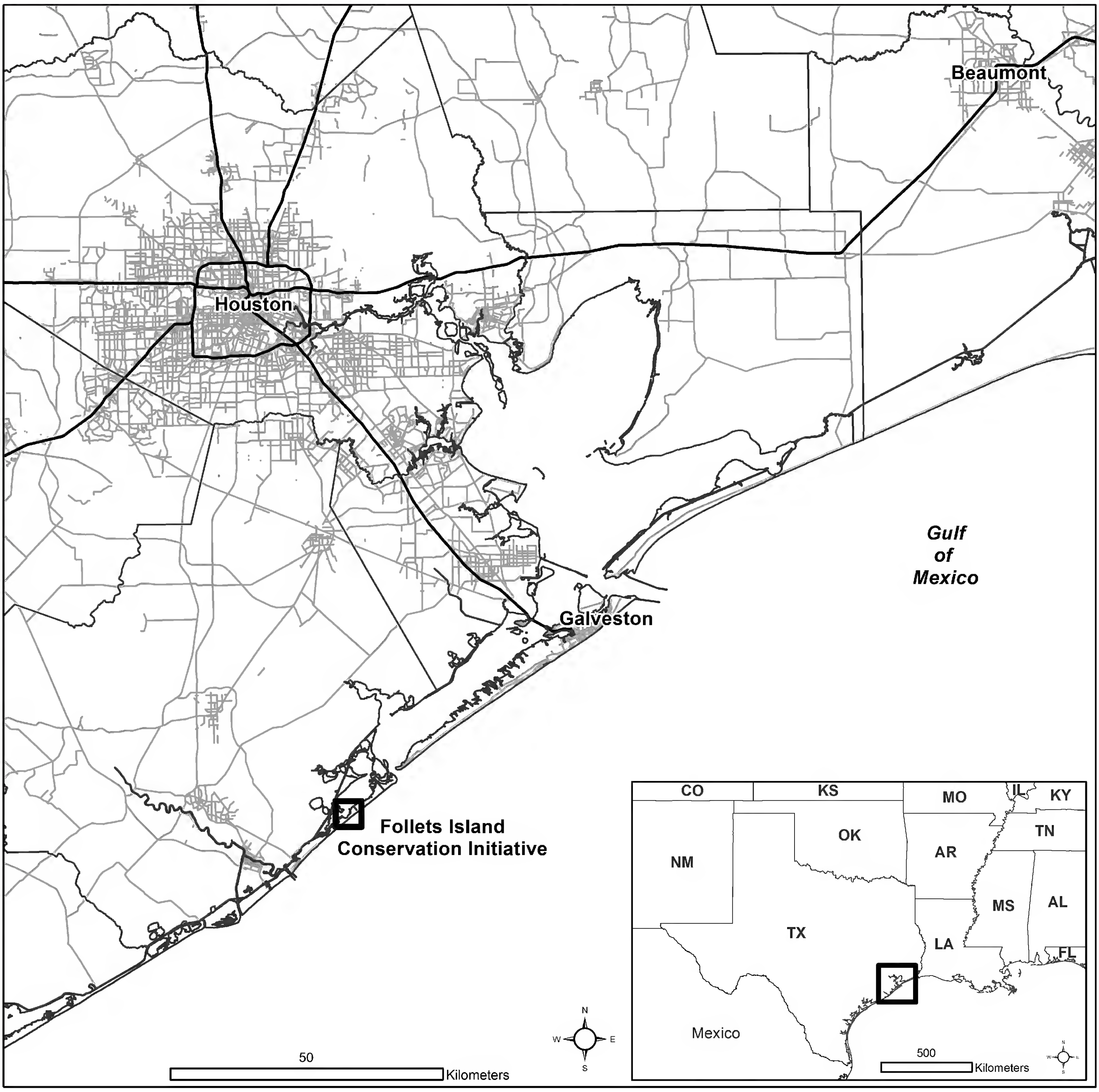
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Fig. 1. General location of The Follets Island Conservation Initiative, Brazoria County, Texas.

## MONOCOTS

### AMARYLLIDACEAE

♦*Zephyranthes chlorosolen* (Herb.) D. Dietr., **i**, 6660, 94

### ASPARAGACEAE

♦[1]*Yucca tenuistyla* Trel., **i**, 6512, 54

### COMMELINACEAE

*Commelina erecta* L. var. *angustifolia* (Michx.) Fernald, **i**, 6576, 71

### CYPERACEAE

**Cyperus esculentus* L., **r**, 6732
♦*Cyperus polystachyos* Rottb., **o**, 6051
*Cyperus retrorsus* Chapm., **o**, 6497, 40
*Eleocharis montevidensis* Kunth, **o**, 6045
*Fimbristylis caroliniana* (Lam.) Fernald, **f**, 6615, 80
**Isolepis cernua* (Vahl) Roem. & Schult., **i**, 6289
*Rhynchospora colorata* (L.) H. Pfeiff., **o**, 6046, 55
♦*Schoenoplectus pungens* (Vahl) Palla var. *longispicatus* (Britton) S.G. Sm., **o**, 6415, 30

### IRIDACEAE

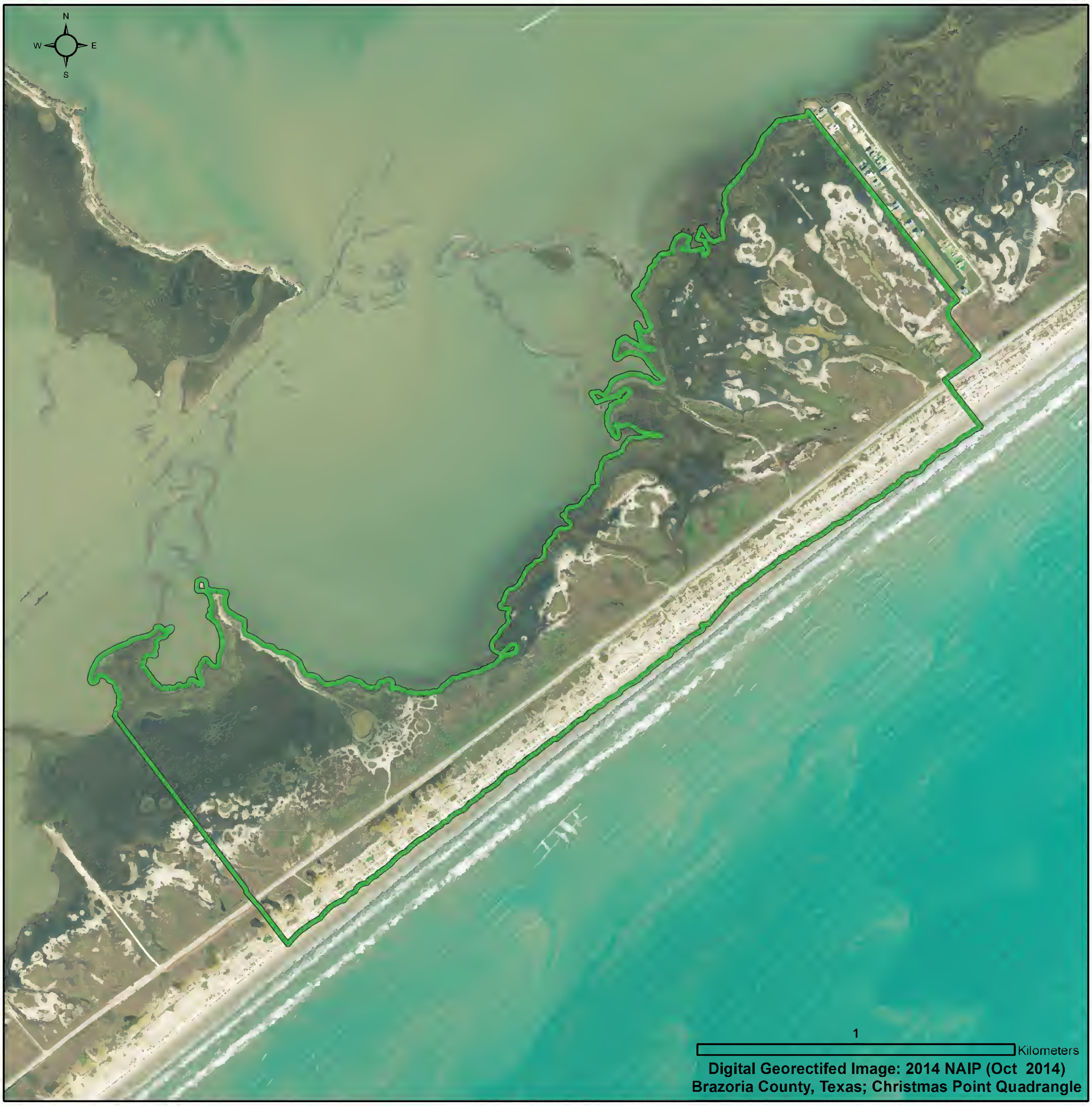
♦[2]*Sisyrinchium biforme* E.P. Bicknell, **i**, 6286, 5

### JUNCACEAE

*Juncus dichotomus* Elliott, **i**, 6421, 34
*Juncus marginatus* Rostk., **o**, 6494, 37
*Juncus roemerianus* Scheele, **o**, 6398, 20
♦[3]*Juncus fascinatus* (M.C. Johnst.) W. Knapp, **o**, 6507, 50

### POACEAE

*Andropogon glomeratus* (Walter) Britton, Sterns & Poggenb. var. *pumilus* (Vasey) Vasey ex L.H. Dewey, **o**, 6680, 108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Brazoria County, Texas; Christmas Point Quadrangle

**Fig. 2. True-color aerial photograph of The Follets Island Conservation Initiative (outlined in green), Brazoria County, Texas.**

*Aristida longespica* Poir. var. *geniculata* (Raf.) Fernald, **r**, 6730
*Aristida purpurascens* Poir. var. *purpurascens*, **i**, 6723
[*]*Bothriochloa ischaemum* (L.) Keng var. *songarica* (Rupr. ex Fisch. & C.A. Mey.) Celarier & J.R. Harlan, **r**, 6724
*Cenchrus spinifex* Cav., **o**, 6666, 99
[*]*Dactyloctenium aegyptium* (L.) Willd., **i**, 6661, 95
♦[4]*Dichanthelium aciculare* (Desv. ex Poir.) Gould & C.A. Clark subsp. *neuranthum* (Griseb.) Freckmann & Lelong, **o**, 6404, 22
*Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark subsp. *acuminatum*, **o**, 6405, 23
♦*Dichanthelium oligosanthes* (Schult.) Gould subsp. *oligosanthes*, **o**, 6417, 32
*Dichanthelium oligosanthes* (Schult.) Gould subsp. *scribnerianum* (Nash) Freckmann & Lelong, **o**, 6406, 24
♦*Dichanthelium polyanthes* (Schult.) Mohlenbr., **o**, 6416, 31
*Dichanthelium sphaerocarpon* (Elliott) Gould, **o**, 6394, 17
♦[5]*Digitaria arenicola* (Swallen) Beetle, **i**, 6727
♦[6]*Digitaria texana* Hitchc., **r**, 6726
*Eragrostis secundiflora* J. Presl subsp. *oxylepis* (Torr.) S.D. Koch, **o**, 6572, 67
*Eustachys petraea* (Sw.) Desv., **o**, 6407, 25
*Muhlenbergia capillaris* (Lam.) Trin., **f**, 6681, 109
♦*Panicum amarum* Elliott, **i**, 6668, 101
*Paspalum monostachyum* Vasey, **o**, 6656, 90
*Paspalum setaceum* Michx. var. *stramineum* (Nash) D.J. Banks, **o**, 6651, 85
§*Schizachyrium scoparium* (Michx.) Nash var. *scoparium*, **a**, 6570, 66
*Setaria parviflora* (Poir.) Kerguélen, **i**, 6569, 65
*Spartina patens* (Aiton) Muhl., **f**, 6561, 60
*Spartina spartinae* (Trin.) Merr. ex Hitchc., **f**, 6498, 41

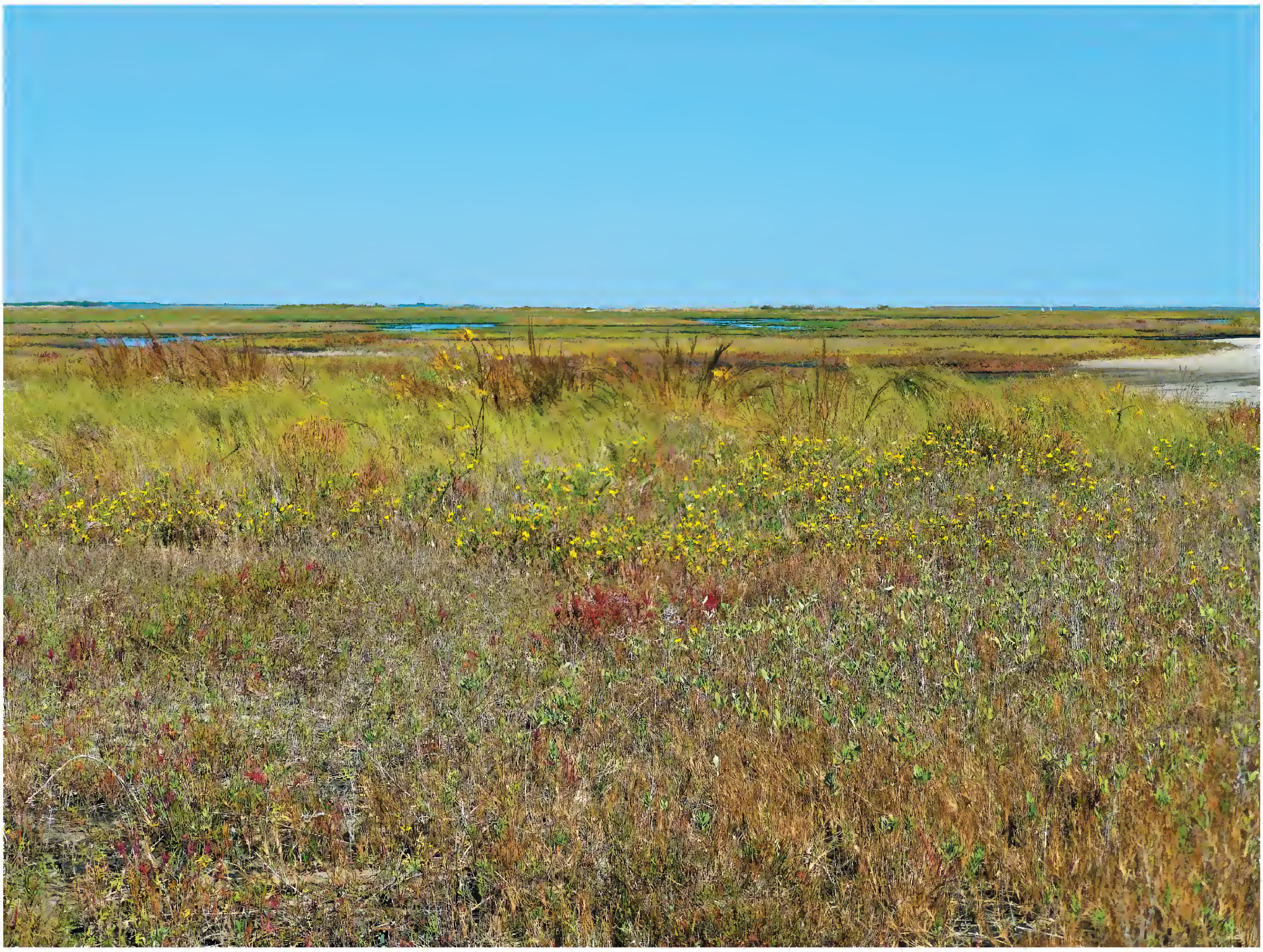

**Fig. 3. Representative photo of strand prairie vegetation on an elevated mound (center) surrounded by other Gulf-shoreline habitat types including vegetated and un-vegetated salt-flats (foreground, right, and aft) and salt-marsh and open water (background).**

Table 1. Taxonomic summary of vascular plants of the 179 ha Follets Island Conservation Initiative. Superscript numbers represent non-native taxa within the total for each rank.

| | Monocots | Eudicots | Total |
|---|---|---|---|
| Families: | 7 | (1)34 | (1)41 |
| Genera: | (3)29 | (3)76 | (6)105 |
| Species: | (4)44 | (3)86 | (7)130 |

*Sphenopholis obtusata* (Michx.) Scribn., **o**, 6400
*Sporobolus pyramidatus* (Lam.) Hitchc., **o**, 6559, 58
*Sporobolus virginicus* (L.) Kunth, **f**, 6560, 59
*Vulpia octoflora* (Walter) Rydb. var. *octoflora*, **o**, 6397

## EUDICOTS

### AMARANTHACEAE

♦*Atriplex pentandra* (Jacq.) Standl., **o**, 6649, 83

### APIACEAE

*Ammoselinum butleri* (Engelm. ex S. Watson) J.M. Coult. & Rose, **i**, 6284
[7]*Polytaenia texana* (J.M. Coult. & Rose) Mathias & Constance, **f**, 6047, 56
♦*Ptilimnium nuttallii* (DC.) Britton, **i**, 6496, 39

### APOCYNACEAE

*Cynanchum angustifolium* Pers., **o**, 6513

### AQUIFOLIACEAE

*Ilex vomitoria* Aiton, **r**, 6684, 112

### ARALIACEAE

*Hydrocotyle bonariensis* Lam., **i**, 6665, 98

### ASTERACEAE

*Ambrosia psilostachya* DC., **f**, 6654, 88
*Aphanostephus skirrhobasis* (DC.) Trel. ex Coville & Branner, **i**, 6056
♦*Astranthium ciliatum* (Raf.) G.L. Nesom, **r**, 6517
*Baccharis halimifolia* L., **o**, 6655, 89
*Cirsium horridulum* Michx., **i**, 6411

*Conoclinium coelestinum* (L.) DC., **o**, 6734,
*Coreopsis basalis* (A. Dietr.) S.F. Blake var. *basalis*, **r**, 6765
♦[8]*Erigeron procumbens* (Houst. ex Mill.) G.L. Nesom, **o**, 6390, 9
*Gaillardia pulchella* Foug., **f**, 6287
*Gamochaeta purpurea* (L.) Cabrera, **i**, 6396, 19
*Heterotheca subaxillaris* (Lam.) Britton & Rusby, **o**, 6292
*Iva angustifolia* Nutt. ex DC., **o**, 6650, 84
*Pseudognaphalium obtusifolium* (L.) Hilliard & B.L. Burtt, **o**, 6300
*Pyrrhopappus pauciflorus* (D. Don) DC., **r**, 6772
§*Rudbeckia hirta* L. var. *angustifolia* (T.V. Moore) Perdue, **o**, 6044, 28
*Solidago sempervirens* L. subsp. *mexicana* (L.) Semple, **f**, 6682, 110

### BRASSICACEAE
*Lepidium virginicum* L. var. *virginicum*, **i**, s.n.

### CACTACEAE
♦*Opuntia stricta* (Haw.) Haw., **o**, 6511

### CELASTRACEAE
*Lepuropetalon spathulatum* Muhl. ex Elliott, **f**, 6281, 4

### EUPHORBIACEAE
*Chamaesyce maculata* (L.) Small, **o**, 6662, 96
*Croton capitatus* Michx. var. *lindheimeri* (Engelm. & A. Gray) Müll. Arg., **i**, 6664, 97
*Croton glandulosus* L. var. var. *lindheimeri* Müll. Arg., **o**, 6659, 93
♦*Croton punctatus* Jacq., **o**, 6504, 47

### FABACEAE
*Acacia farnesiana* (L.) Willd., **r**, 6403, 21
♦*Astragalus leptocarpus* Torr. & A. Gray, **o**, 6293, 8
[9]*Baptisia bracteata* Muhl. ex Elliott var. *laevicaulis* (A. Gray ex Canby) Isely, **f**, 6291, 7
*Chamaecrista fasciculata* (Michx.) Greene, **o**, 6575, 70
♦*Dalea emarginata* (Torr. & A. Gray) Shinners, **i**, 6495, 38
♦*Erythrina herbacea* L., **r**, 6516, 57
*Indigofera miniata* Ortega, **i**, 6055
*Mimosa strigillosa* Torr. & A. Gray, **i**, 6663
*Neptunia pubescens* Benth. var. *pubescens*, **r**, 6520
♦*Rhynchosia americana* (Mill.) Metz, **i**, 6048
♦*Rhynchosia minima* (L.) DC. var. *minima*, **i**, 6049
♦*Strophostyles helvola* (L.) Elliott, **o**, 6667, 100
*Strophostyles leiosperma* (Torr. & A. Gray) Piper, **o**, 6565, 63
*Vicia ludoviciana* Nutt. ex Torr. & A. Gray, **o**, 6297

### GENTIANACEAE
*Eustoma exaltatum* (L.) Salisb. ex G. Don, **o**, 6562, 61
§*Sabatia campestris* Nutt., **o**, 6393, 16

### GERANIACEAE
*Geranium carolinianum* L., **o**, 6298

### LAMIACEAE
*Monarda punctata* L., **o**, 6418, 33
♦*Scutellaria drummondii* Benth., **i**, 6050
♦*Teucrium cubense* Jacq. var. *cubense*, **i**, 6054, 29

### LINACEAE
♦[10]*Linum alatum* (Small) H.J.P. Winkl., **o**, 6295, 27
♦[11]*Linum imbricatum* (Raf.) Shinners, **o**, 6052
*Linum medium* (Planch.) Britton var. *texanum* (Planch.) Fernald, **o**, 6043

### LYTHRACEAE
*Lythrum alatum* Pursh var. *lanceolatum* Torr. & A. Gray ex A. Gray, **o**, 6580, 73

### MALVACEAE
*Kosteletzkya virginica* (L.) C. Presl ex A. Gray var. *althaeifolia* Chapm., **r**, 6613, 78

### MYRICACEAE
*Morella cerifera* (L.) Small, **r**, 6568

### ONAGRACEAE
♦*Calylophus australis* Towner & P.H. Raven, **i**, 6057, 18
*Oenothera drummondii* Hook., **f**, 6283, 2
♦[12]*Oenothera patriciae* W.L. Wagner & Hoch, r, 6420

### OROBANCHACEAE
*Agalinis heterophylla* (Nutt.) Small, **f**, 6648, 82
*Agalinis maritima* (Raf.) Raf., **i**, 6053
§*Buchnera americana* L., **i**, 6061
*Castilleja indivisa* Engelm., **o**, 6290, 6

### OXALIDACEAE
*Oxalis violacea* L., **r**, 6683, 111

### PHYTOLACCACEAE
*Phytolacca americana* L., **r**, 6688, 115

### PLANTAGINACEAE
♦[13]*Plantago hookeriana* Fisch. & C.A. Mey., **o**, 6408, 26
*Plantago virginica* L., **o**, 6299, 10

### POLYGALACEAE
♦*Polygala verticillata* L., **i**, 6060

### POLYPREMRACEAE
*Polypremum procumbens* L., **i**, 6059

### PRIMULACEAE
*Anagallis arvensis* L., **r**, 6769
*Anagallis minima* (L.) E.H.L. Krause, **o**, 6280, 3
*Samolus ebracteatus* Kunth, **i**, 6392, 15

### ROSACEAE
*Rubus trivialis* Michx., **f**, 6282, 1

### RUBIACEAE
*Diodia teres* Walter var. *teres*, **o**, 6657, 91
*Diodia virginiana* L. var. *virginiana*, **o**, 6658, 92
*Houstonia pusilla* Schöpf, **i**, 6285
*Stenaria nigricans* (Lam.) Terrell, **o**, 6503, 46

### RUTACEAE
♦*Zanthoxylum fagara* (L.) Sarg., **r**, 6686, 113

### SAPOTACEAE
*Sideroxylon lanuginosum* Michx. var. *oblongifolium* (Nutt.) B.L. Turner, **r**, 6687, 114

### SOLANACEAE
[14]*Physalis cinerascens* (Dunal) Hitchc. var. *spathulifolia* (Torr.) J.R. Sullivan, **o**, 6389, 12
♦*Solanum triquetrum* Cav., **r**, 6689, 116

### TAMARICACEAE
*_Tamarix ramosissima_ Ledeb., **r**, 6519

### VERBENACEAE
*_Lantana camara_ L., **r**, 6677, 105
*_Phyla nodiflora_ (L.) Greene, **i**, 6493, 36
§Verbena halei Small, **f**, 6402

### VITACEAE
♦*Cissus incisa* Des Moul., **r**, 6685

## APPENDIX 2: CONSERVATION NOTES

1. ***Yucca tenuistyla***: Endemic to coastal Texas from Galveston County to South Texas, inland to Milam County (Keith 2015).
2. ***Sisyrinchium biforme***: In coastal dunes and inland sandy river banks of Texas, Louisiana, and coastal northern Mexico (Cholewa and Henderson 2002).
3. ***Juncus fascinatus***: Endemic to streams, seeps, and coastal sites in north-central and southeastern Texas (Knapp 2014).
4. ***Dichanthelium aciculare*** subsp. ***neuranthum***: Texas represents the western edge of the range of the species where it is "rather rare-a nice find" (Freckman 2014).
5. ***Digitaria arenicola***: Endemic to deep coastal sands of Texas and is mapped by Wipff and Hatch (1994) as seeing its northern-most records from adjacent Galveston County. Our collection is the first record from Brazoria County, and the second on a protected site in southeast Texas.
6. ***Digitaria texana***: A Sandy-prairie species known only from the Texas' coast and Rio Grande plains (Correll & Johnston 1970).
7. ***Polytaenia texana***: Described by Nesom (2012) as a "near-endemic" restricted to most of Texas and southern Oklahoma and occurring in most of the prairie habitat types.
8. ***Erigeron procumbens***: Restricted to coastal sands in Louisiana, Texas, and Tamaulipas (Correll & Johnston 1970).
9. ***Baptisia bracteata*** var. ***laevicaulis***: Based on distributions described by Isely (1990) and Correll and Johnston (1970), we interpret this *Baptisia* as endemic to the coastal plain of southwest Louisiana and southeast Texas.
10. ***Linum alatum***: Open areas with sandy soils in south-central Texas and northeast Tamaulipas (Correll & Johnston 1970).
11. ***Linum imbricatum***: Open areas with sandy soils in east-central Texas (Correll & Johnston 1970).
12. ***Oenothera patriciae***: A colonial species of open sandy places throughout central and east Texas (as *Gaura brachycarpa* Small in Correll & Johnston 1970).
13. ***Plantago hookeriana***: Correll and Johnston (1970) describe this species as "possibly endemic" and occurring from east Texas along the coast to the Rio Grande Valley, and inland to the Trans Pecos.
14. ***Physalis cinerascens* var. *spathulifolia***: Sandy beaches and plains along the Texas coast into Lousiana (Correll & Johnston 1970).

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# IN MEMORIAM: ROBERT R. “BOB” KOWAL (23 APRIL 1939–3 AUGUST 2015)

Theodore S. Cochrane

*Senior Academic Curator Emeritus*
*Wisconsin State Herbarium*
*University of Wisconsin-Madison*
*430 Lincoln Dr.*
*Madison, Wisconsin 53706-1381, U.S.A.*

**Robert R. Kowal, October 1986, in his backyard *Packera* transplant garden.**

Dr. Robert Raymond Kowal, affectionately known as “Bob” to his friends, colleagues, and students, died in Middleton (a satellite of Madison), Wisconsin, on August 3, 2015, at the age of 76 after suffering from the effects of multiple brain tumors. He was a Professor of Botany at the University of Wisconsin-Madison (1971–1997).

Kowal, who was born and raised in Paterson, New Jersey, developed a love of nature as a young boy. He was captivated not only by the flowers his mother grew in his family’s garden and the many house plants she kept inside, but also by butterflies, in which he showed a keen interest while in high school. Armed with basic equipment, he collected butterflies in the vicinity of home, carefully “relaxing” and spreading his specimens before mounting them. Having led a rather introverted life while a youth, Kowal “really bloomed” (in the words of his brother Norman) once in the college environment at Cornell University, where he enrolled as a scholarship student, majoring in botany, minoring in biometry and statistics as well as genetics, and graduating as class valedictorian in 1960. He continued his academic training at Cornell, pursuing graduate studies under the guidance of Robert T. Clausen, and in 1968 earned his doctorate in plant taxonomy and ecology. Kowal’s dissertation was based on three summers of field research conducted on *Senecio* in Quebec, and among his publications (listed below) the published version of this work deserves to be mentioned in particular. Kowal was also greatly interested in cytotaxonomy and numerical taxonomy, and he developed a good working knowledge of the *International Code of Botanical Nomenclature* (while it was still known by this longer title). He held a post-doctoral fellowship in the biomathematics program at North Carolina State University during 1967–69. His first academic appointment was a visiting assistant professorship in biology at Kansas State University in 1969–71, where he was a colleague of fellow *Senecio* enthusiast Theodore M. "Ted" Barkley. In the fall of 1971 he accepted a faculty position in the Department of Botany at the University of Wisconsin-Madison, retiring in 1997.

His dual interests in botany and statistics served Kowal well, and he was nationally recognized for his expertise in the use of biomathematics to understand the genetic variability of natural plant populations. Although traditional in his own working methods, he was always open to new developments and familiarized himself with modern trends in botanical research.

A dedicated teacher, Kowal regularly taught a high-enrollment general botany course to an entire generation of UW students, and he won the appreciation and fondness of undergraduate majors and graduate students who took his advanced courses on the spring flora of Wisconsin, dendrology, advanced plant taxonomy, community analysis, biological diversity, and plant geography, as well as seminars on plant taxonomy and workshops on the taxonomy and evolution of the Compositae. His laboratory and field research focused on plant taxonomy and evolution; he traveled throughout the U.S., southern Canada, and Mexico, researching the tribe Senecioneae, especially his passion, the aureoid senecios (*Packera*). Although not a prolific collector, he always insisted on producing complete, good-quality specimens and labels.

Kowal, who long chaired the Department of Botany's Greenhouses and Garden Committee, eagerly shared his delight in plants with staff, friends, and neighbors alike. His exuberant home garden was stocked with a wide range of plants but was most notable both for its ornaments and for the range of daylily, peony, and hosta cultivars. For his house and office he favored bold plants like *Alstroemeria*, *Amaryllis*, *Clivia*, and *Hibiscus*, the brightly colored flowers of which demand admiration. Besides being utterly fascinated with plants, Kowal was an avid swimmer and sometime jogger and flute player, and he loved classical music (especially opera) and reading. He recognized the need to protect the plants he loved and their habitats and was a longtime generous supporter of environmental organizations and other good causes. In accordance with his wishes, Kowal's body was donated to the University of Wisconsin School of Medicine.

An individualist with his own obsessions, Kowal was unrepentant about his shabby dress, and even though he disliked bureaucracy and was uncharitable toward shaky ideas, sloppy botany, and slipshod writing, departmental staff will nonetheless remember him as a remarkably gentle and patient man. He always found time to assist students and others who came to him with questions and requests. Above all, he was an excellent botanist.—*Ted Cochrane, Senior Academic Curator Emeritus, University of Wisconsin-Madison*

**PROFESSIONAL SOCIETIES:**
The American Association for the Advancement of Science
The American Society of Plant Taxonomists
The Botanical Society of America
The International Association for Plant Taxonomy
The New England Botanical Club
Society for the Study of Evolution
Torrey Botanical Club

**HONORS:**
Phi Beta Kappa
Honorary Woodrow Wilson Fellow
Sigma Xi
Phi Kappa Phi
Study leave (sabbatical) for the academic year 1989–90, at Kansas State University and in Mexico

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## NEW TAXA AND NEW COMBINATIONS:

ASTERACEAE **Senecio galicianus** McVaugh var. **manantlanensis** Kowal—Brittonia 43(2):109. 1991.

ASTERACEAE **Packera paupercula** (Michx.) Á. Löve & D. Löve var. **savannarum** R.R. Kowal—Novon 18(2):222. 2008.

ASTERACEAE **Packera paupercula** (Michx.) Á. Löve & D. Löve var. **pseudotomentosa** (Mack. & Bush) R.R. Kowal—Novon 18(2):224. 2008.

ASTERACEAE **Packera insulae-regalis** R.R. Kowal—Brittonia 63(3):345. 2011.

ASTERACEAE **Packera crawfordii** (Britton) A.M. Mahoney & R.R. Kowal—Phytoneuron 2015–18:1. 2015. [e-published.]

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## PERSONAL TRIBUTES:

*Some personal reminiscences*—Bob Kowal and I were colleagues for more than 30 years. He was a next-door neighbor in Birge Hall for much of that time, during which he graciously and generously shared his expertise and lab space, often befriending the graduate students who came and went. I first met Bob during my job interview in the spring of 1978. He was a kindred spirit, our having shared interests in evolutionary diversification, within-species variation, and using statistics to analyze this variation. He was also welcoming and humble, qualities to comfort a new assistant professor. I was happy to accept his generous invitation to stay with him in his apartment overlooking Lake Mendota later while I was looking for a place to live in Madison. I recall an apartment overrun with a luxuriance of plants, including a blooming hibiscus. It was clear he took a simple and direct pleasure in all things botanical.

Bob devoted great time and effort to teaching our flagship Botany 130 course, often working the evening before as well as rising early those mornings. During the first class of the semester, he would describe the parts of a plant, working with a potted specimen. Once through the leaves, stems, and flowers topside, he would ask the class: "What are we missing?" Then, sometimes with the question, "Should I?" or a pregnant pause, he would smash the pot down on the counter to expose the soil and roots. Any slumbering student would jolt awake, and no one could ever forget the lesson. Succeeding lectures had a train of their own props, including an actual miniature train to hammer home concepts of DNA transcription and translation.

With graduate students and colleagues, Bob was always more than ready to lend his expertise. Those seeking instruction in cytology knew that Bob was the "go-to" guy for this, even into his retirement years. Earlier in his career, he was also the department's authority for biostatistics, capitalizing on his post-doc work at North Carolina State. When I asked him once why he didn't pursue National Science Foundation grant funding for his own research, he responded that if he did get a grant, he would have to spend time being an administrator and would lose time to do the research himself. It was thus gratifying to see him become so happily engaged with his research once he retired. [Kowal did submit two proposals to the NSF in the 1970s but was not successful in gaining support.—*T.S.C.*]

Those of us who socialized with Bob soon learned of his self-deprecating sense of humor and sometimes also his maladies. On a postcard he sent back to the office staff from a trip to Puerto Rico, he talked about the tropical wonders of where he was and added: "Alas, I'm still me." Many of us knew of his difficulties sleeping at night. He tried various solutions, but I'm not sure any worked. He correspondingly made it a habit to take an afternoon nap on a cushion he kept rolled up in his office. Being a regular swimmer, Bob was also remarkably fit. At the pool, I would watch him keep up a steady pace, lap after lap after lap.

When Bob bought a house with a double-size lot on the west side, he was able to take his love of plants outdoors. The yard was never the same. Bob was always happy to give tours of his garden, providing a graduate seminar in the art of cultivating daylilies and *Senecio* relatives along the way.

We will all greatly miss Bob—for his strengths and his foibles.—*Don Waller, Professor of Botany, University of Wisconsin-Madison*

*Reminiscences*—Bob joined the faculty shortly after I did. He was an intellectual in the department when others are mostly just clever. And he was a good moderating influence. I felt very close to him. What great strength he had in retiring early, so as to do his work the way he wanted. He was a gentleman scientist, of which there are so few these days. He and I both eschewed vulgar careerism, and we felt a special resonance. Bob was a great scientist, showing how the trappings of success do not amount to much. But his work will be cited long after that of others when their gimmicks are forgotten. Great things are achieved in humility. I loved his *Senecio indecorus* work on the Gaspé Peninsula from his early days, showing that petals cost. I think he knew of my special affection. I hope so. He had a full life well lived. I am proud to have known him.—*Tim Allen, Professor Emeritus of Botany, University of Wisconsin-Madison*

*Reminiscences*—I was an acquaintance of Bob's over the years, knowing him first as a reviewer for research proposals to the National Science Foundation. I could always count on him for conscientious appraisals in his specialty areas of biomathematics and the Composite Family, especially anything "senecioid." He was a good citizen.

During my 1990–91 sabbatical year as a Visiting Professor at the University of Wisconsin, I interacted only lightly with Bob but learned from many appreciative students of his teaching talent and dedication, and as well of his strong support for the Department of Botany Greenhouses and Garden. His own large garden was an idiosyncratic jungle of delights, rich in plants and oddball ornaments. He was a knowledgeable plantsman.

In 2007 Bob allowed me to stay in his spare bedroom while I paid final visits to a friend in hospice care, a visit that proved all too brief. Bob was gracious and consoling—a generous human being who will be missed by many.—*Jim Rodman, retired, formerly a program director at the National Science Foundation*

*Some personal reminiscences*—I was Bob's ultimate–in the sense of "last"–graduate student. Bob was very particular about using the right word; he once rather firmly reminded me when I'd used a word incorrectly that "words have meaning!" His graduation gift to me was a two-volume Oxford dictionary. It's in my office at Mankato State University, where I teach; I consult it all the time.

I earned a bachelor's degree in studio art with a minor in French at UW-Oshkosh in 1976. But having loved plants and gardening since childhood, I decided to return to school with the intention of earning a master's degree in botany with an emphasis on ecology. I met Bob in 1994 as a student in his marvelous Spring Flora of Wisconsin course, which convinced me that I wanted to be a plant systematist. I asked Harvey Ballard, who was Bob's penultimate graduate student and my lab instructor, if he thought Bob might be willing to take me on as a grad student. Harvey encouraged me to ask him; I will always be grateful that Bob said, "Yes."

I remember with great pleasure our preparing to take to the field. The two of us took a 10-day driving trip through the southeastern U.S. in 1995 to collect living *Packera* plants for our common garden experiment, which we set up in his backyard. Supplied with locations of *Packera* populations of interest from herbarium specimen labels, we'd follow circuitous driving instructions, and eventually Bob would pull his Subaru station wagon to the roadside. We'd get out and gird up our loins. We'd tuck in our shirts, roll down our sleeves, button our cuffs, and tuck our pants legs into our socks. Then we smeared a yellow copper sulfate powder that Bob used to prevent powdery mildew on his plants around our waists and shirt and pants cuffs to prevent chiggers. I guess it worked. In his breast pocket, Bob carried his hard-cover pocket-sized notebook and a fine-tipped Rapidograph pen, a fussy instrument that frequently clogged and had to be shaken before it would write. He strapped on a bag containing his camera, labels on string, and his prized trowel with the wooden handle worn to the shape of his palm.

Bob had a pile of tough plastic bags into which we put our quarry: *Packera* plants that were kept alive in coolers for the duration of our trip. He tied an enormous plastic bag to his belt into which he put our smaller bags and other plants of interest to be keyed out later. Despite the heat and humidity, Bob's long legs carried him tirelessly up and down steep slopes and straight through brush. I scrambled after him. I think we must have looked a bit like Don Quixote and Sancho Panza.

Bob was exacting, precise, patient, and kind. Just about everything I know about collecting and pressing plants, keeping records, and writing clearly comes from him. When I teach my Flora of Minnesota class, most of it comes right out of his course at the UW. I tell my students, when they're sloppy, "words have meaning," and hope that in some small way Bob's passion for plants and quest for precision in record-keeping and the use of language pass through me and on to the next generation of botanists. Thank you, Bob!—*Alison Mahoney, Professor of Botany, University of Minnesota-Mankato*

*Reminiscences*—I had met Bob during an early visit to the University of Wisconsin campus and reinitiated contact with him via e-mail prior to my application to the Ph.D. program in the Department of Botany. Bob expressed interest in serving as my major professor to train me in traditional systematic approaches and suggested that Ken Sytsma and Hugh Iltis could fill in the other areas. Immediately upon arriving for my first semester in Madison, I hunted down Bob's office and excitedly introduced myself. He seemed eager to have a new graduate student. Over the next couple of weeks, I checked in with him first thing every day—why, I'm not sure—and we chatted briefly about what he was doing that day and what I was doing or attempting to do. At the end of each day, this scenario was repeated. Sometimes these conversations became quite animated when something one of us mentioned sparked great interest, as we both thoroughly enjoyed discussing taxonomy and nomenclature, systematic theory, evolution, and specific methods. He never told me he was too busy, and I never got the sense that I was out of line; but, soon becoming concerned that I might be abusing his accessibility, one afternoon I asked him whether I was taking too much of his time or bothering him. He cocked his head as a thoughtful look passed across his face. "No, no," he said. "I'll let you know when I'm too busy. I'm enjoying our conversations, and it's been awhile since I've had much opportunity to discuss taxonomy or other things with anybody." I learned from Bob's example that students come first unless something desperately important was looming and requiring my time. I also discovered that opportunities to discuss aspects of our discipline with Bob and others in the department were just as important for my training and professional development as coursework, research, and teaching.

My teaching assistant positions included Bob's introductory botany course. There, I witnessed his teaching style, a mixture of a little overacting, a healthy dose of humor, an occasional skit or demonstration to emphasize a point, and lots of enthusiasm for the subject. I learned from Bob that with new science majors or non-majors, it is critically important to capture the students' attention, and he had worked out for himself the most successful pedagogical approaches. Bob could make every class period exciting and memorable, and even after teaching the same course for decades, he showed no sign of becoming jaded or bored. This was clear proof of how much he invested in the course to provide his students with a quality experience. I later incorporated these lessons into my own teaching.

As my research progressed and I began to write manuscripts, I discovered Bob's outstanding capacity for writing and editing. In the first few months of our regular interactions, he bought me Strunk and White's little hardbound book *The Elements of Style* and urged me to read it cover to cover, which I did. I was dismayed at the extent of his marks and comments on every chapter I gave him for review; sometimes we worked through several bouts of changes and corrections, but I ultimately benefited from his placing great value on precision and correctness. It wasn't that Bob necessarily had to be right, but that he wished everyone to be as precise as he could. He was especially dismayed by my fervor to use ten words where one would do, as he put it, or to write florid language instead of plain English. He constantly preached that good writing—scientific or otherwise—should be terse, precise, and simple to understand. His lessons were strikingly apparent in a paper based on a dissertation chapter, in which we discussed the evolution of the Hawaiian *Viola* lineage inferred from DNA internal transcribed spacer (ITS) sequences. I gave Bob the "semi-final" draft to review. After three rounds of corrections, he essentially dismantled it and put back together in a quite different format. We submitted the manuscript to the journal *Evolution*. One of the reviewers stated that it was one of the cleanest and most beautifully written he had ever had the pleasure to review. I knew that assessment derived from Bob's handiwork. I am more aware of what makes good writing thanks to Bob's perspective, and when criticizing my own and others' writing while wearing my "Bob hat," I've been able to tighten up the prose significantly.

Bob referred to himself as a "biosystematist," one who applies a wide range of methodologies to delineate evolutionarily distinct sets of populations, and his having employed statistics, cytogenetics, and observations from field and test garden studies while studying the difficult group *Packera* led me to identify him as a possible mentor. Since high school, I had been engaged in traditional taxonomic studies of plants, especially violets, the species of which are often difficult to distinguish, and had begun conducting phenetic studies, primitive flavonoid identification, and SEM examination of leaves and flowers of violets when I got to the UW-Madison. Bob enthusiastically supported my interest in gaining experience with any approach that might prove taxonomically useful. He was more than willing to provide as much guidance or assistance as one could want, and he strengthened and extended my statistical understanding and competence. At one point I requested that he give me some help in obtaining chromosome counts for the very rare *Viola frank-smithii*. He advised me on possible fixation solutions for flower buds, information I passed along to a collaborator in Utah, who gathered buds and sent them to us. For the next three months, Bob took time to show me how to prepare tissue for squashes and how to examine slides for good squashes. Freely acknowledging the limits of his own experience, he was eager to see me learn molecular systematic methods under Ken Sytsma's tutelage. I have continued Bob's legacy by passing on serious training in traditional methods and nomenclature, as well as molecular approaches, to all my graduate students and many undergraduates.

While contributing in numerous ways to the professional botanist I am today, Bob also quickly became a good friend and eventually a very dear friend. During the early weeks of our time in Madison, my partner and I began meeting Bob and his partner Jim every Friday evening for supper and sometimes a cultural performance or a movie afterwards. Bob and Jim became our "big brothers," and we relished the socializing and mutual venting sessions we shared. Bob and I also made many trips to conferences together (during which I always brought my earplugs with me to muffle his snoring), as well as occasional trips into the field. I shared Bob's enthusiasm, nay, childlike delight, in natural diversity, and we had great fun simply studying plants. Like most visitors to Bob's home, I was subjected to the inevitable garden tour, but no matter what the season, it was always a treat. Like the man himself, the gardens, which occupied the back, front, and sides of the house, were slightly disheveled, but their diversity (especially of day lily and peony cultivars) was astonishing for the modest size of the yard.

While working assiduously at his job, Bob also made time for his partner, his friends, and especially his beloved garden, and he continued investing regular amounts of time into his research long after retirement. This strategy, too, has been a continuing lesson I still attempt to apply in my own life. I am grateful to have been mentored and inspired by Bob Kowal, but I am even more grateful for the close friendship we shared. He was funny, thoughtful, passionate, compassionate, and unpretentious. He made time for others and took delight in sharing his knowledge of and enthusiasm for plants. He was an outstanding role model for me, professionally and personally, and I miss him greatly.—*Harvey Ballard, Jr., Associate Professor of Plant Biology, Ohio University*

*Remembrances and reflection*—Memories I have of Bob include those dating from December 1974 and January 1975, when he accompanied taxonomy graduate students on a plant collecting trip to Central America. Dumbfounded customs officials at the international airport of Panama City didn't know how to react to his bedroll—a sponge rubber mattress complete with sheets we dubbed "the marshmallow"—taller than he was and bigger around than he could reach. One of the first plants we learned while there was *Scheelia zonensis*, a conspicuous feather palm along the Pacific coast of Panama. Now, Bob was a very intelligent man who was meticulous about Latin pronunciations, but for some reason he couldn't learn the name *Scheelia*. It invariably came out wrong, no matter how often he spoke it. However, he did take better quality color transparencies than any of the rest of us. Soon after lunch on the way back to Madison we stopped at the Audubon Society's famous Corkscrew Swamp Sanctuary in the western Everglades. While the rest of us were marveling at the old-growth bald cypress trees and many epiphytes, I could see that Bob was growing more and more anxious. Suddenly, he asked me for the car keys, turned, and ran back the length of the boardwalk. When he returned a while later, I looked at him quizzically. "I had to brush my teeth," he answered. In fact, he brushed his teeth so often that eventually his dentist told him to cut back; he was damaging the enamel. Among the many other things I remember about Bob are his digging bomb craters all over his yard in which to plant plants, his diverse collection of baseball-style caps (many faded or dirty), his creative and hilarious blackberry costume for a Halloween party, his capacity for ingesting voluminous amounts of food, the large quantities of olive oil he used when cooking, and how loudly and continuously he could snore—all night. The first and last night I ever spent in the same room with him (I made sure of that!), his snoring prevented me from falling asleep for even one second from 11:00 p.m. 'til 7:00 a.m. Fellow sufferer Andrew Hipp, sacked out on the floor in the adjoining porch, crawled over to me on his hands and knees at one point in the early morning and exclaimed, "Ted! That's Bob snoring! I thought the house was breaking!"

It was a testament to Bob's commitment to teaching that each semester, year after year, when it was approaching 9:00 or later at night and I was on my way out of the building, he would be seated in his office under that big north-facing window he loved, writing out anew, longhand, the next day's lecture or the next week's exam. He was not one to reuse the same notes from one year to the next. The exams he gave in his advanced taxonomy class reminded us students of the high standards to which we were being held. After all, he was committed to high standards for himself. Bob was a critical thinker. During plant taxonomy seminars he would quickly see the crux of matters being discussed and express the points he made with great clarity. In departmental committee meetings he was extremely conscientious, fair-minded, and reasonable.

Bob was one of a kind, a singular individual, his own man, even slightly eccentric. Neither charming nor cantankerous, he was, well, Bob—a man who was who he was at every moment. The idiom "what you see is what you get" is an accurate portrayal. No one could be more down to earth, more direct, more honest than Bob was. What he told you in private was exactly what he would say in public. Bob was absolutely devoid of pretense, wholly accountable in all that he said and all he supported.

Bob was a friend who showed me more loyalty than I thought I was due. But at the same time he could also be an unsparing critic, albeit an unreservedly helpful one, when, for example, reading theses and manuscripts.

I had enormous respect for Bob's carefully thought-out positions, and we could talk about anything, as we did, for example, on long car rides traveling to the Annual Systematics Symposium at the Missouri Botanical Garden: taxonomic questions; environmental preservation and conservation, including the heedless destruction of biological diversity, the mindless consumption of material possessions, and the unsustainable increase in human population; politics; social injustices; personal finances; music; sex; death. He always spoke the truth as he knew it, about his views, his feelings, and his life.

A profound joy in living marked Bob's life, and a remarkable serenity as he lived out his last days. I will miss his wisdom, pragmatism, and friendship.—*Ted Cochrane, Senior Academic Curator Emeritus, University of Wisconsin-Madison*

*Remembering Bob Kowal*—As a 19-year-old transfer student in 1974, I picked a major called "Biological Aspects of Conservation" and was assigned an advisor, whom I was told to go find and talk to about program requirements. The memories of navigating Bascom Hill, finding Birge Hall, and knocking on the door of my advisor, Bob Kowal, remain unusually vivid. The man sitting across the desk from me was youngish, serious, and, I suspected, somewhat unenthused about having to speak to another young undergrad seeking advice about course requirements for a major that was somewhat outside of his usual purview.

Fast forward to 1989, when I was offered the position of Head of the Biology Library in Birge Hall. Bob came into the library often in those days, and every spring he would bring the staff a vase of beautiful tree peonies from his garden. I gradually came to know him better and to like him more. I respected him for his scholarly, serious manner and for being one of the more constant faculty users of the library. I liked him for his quirky, irreverent sense of humor and, as years went on, for being a caring person, a *mensch*. Our relationship evolved slowly so that I became happy at the sight of Bob walking through the library door, because we would converse not only about botanical papers, but also about sleep deprivation, depression, and other more personal concerns. Besides the transcendent beauty and wonder of the plant world, we had some kind of mutual understanding about the vicissitudes of life.

During those years Bob began asking if I would like any daylilies from his garden. "Yes," I would answer, and soon he would stop by and leave a plastic bag containing the plants in the shade near the front door. Once, when we were crossing University Avenue together, I made the mistake of mentioning how fond I'd become of the "Co-ryd-A-lis" in my garden. Bob startled me when he exclaimed at the top of his lungs, "No, No, No! The accent is on the antipenultimate syllable! It's not 'Co-ryd-A-lis,' it's 'Co-RYD-a-lis.' Three syllables from the end, not two! Nothing drives me crazier than people putting the accent on the wrong syllable!" It was a memorable lesson that I never forgot and still check myself on, even today.

Beginning in 2006 I had a series of setbacks to my health. Bob would bring me plants from his garden and transplant them for me once yard work became hard for me to do. We began going to matinees together on a somewhat regular basis. I loved going to the movies with Bob, because it meant I had a chance to enjoy his quirky humor and gentle friendship. I loved it when he laughed spontaneously and loudly at places in the movie where the rest of the audience was silent. He was so much his own person. Our matinee afternoons were often followed by a stop at the adjacent Pendleton store (I learned that orange was Bob's favorite color and that he was susceptible to spending money on shirts) and dinner out. Bob would pick up the tab, saying that he had more money than he knew what to do with. One time Bob invited me to go to the opera with him, saying that I should rest assured he would get the best seats available. They turned out to be in the first row, center.

These are but a few of many memories I have of Bob. He was much loved by all of us, because he was funny, smart, quirky, kind, and generous. He helped me greatly after I retired and was struggling with physical pain and isolation. He brightened my life. One could not have had a better friend.—*Elsa Althen, former head of the Biology Library, University of Wisconsin-Madison*

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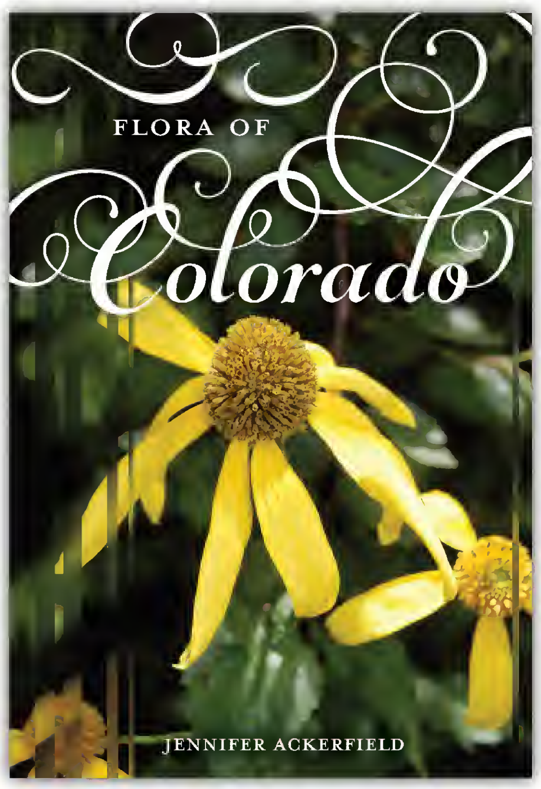
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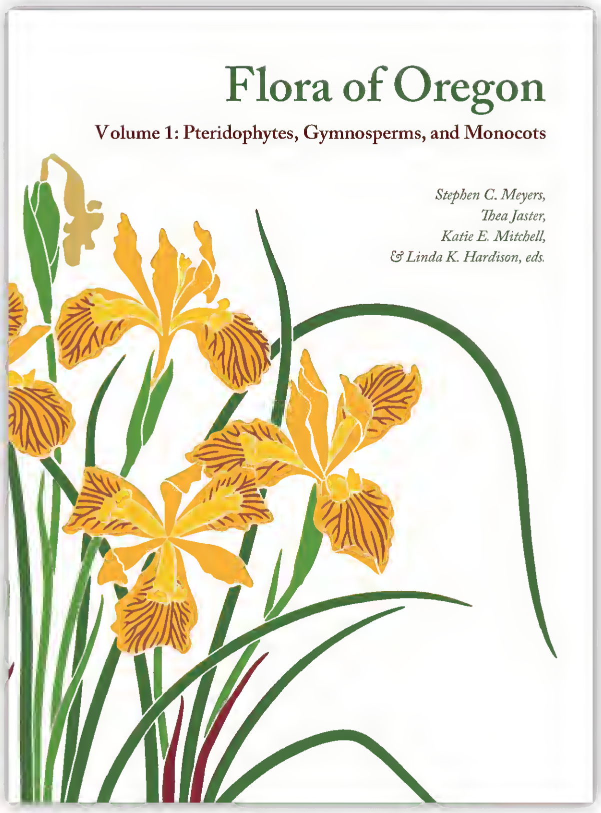
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